



**MODELLING WITH COMMERCIAL EGG POWDER TO ASSESS THE  
POTENTIAL OF INDIGENOUS KNOWLEDGE-PROCESSED EGG POWDER TO  
IMPROVE HOUSEHOLD FOOD AND NUTRITION SECURITY**

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## **ABSTRACT**

Eggs have potential to improve the nutritional status of individuals who are at risk of Protein-Energy Malnutrition in rural households of South Africa. However, eggs have a short shelf-life and rural households have limited or no access to modern preservation technologies. Therefore drying eggs into egg powder to increase their shelf-life could be a feasible egg preservation technique for rural households. The aim of this study was to use commercial egg powder as a model to assess the potential of indigenous knowledge-processed egg powder to improve household food and nutrition security of rural households of Mkhambathini in KwaZulu-Natal province of South Africa.

A total of 110 household representatives participated in the survey which was conducted to explore the importance of eggs in rural areas of Mkhambathini local Municipality by assessing egg production, utilisation and the perceived value of eggs by rural households. From the survey participants, 20 adult women and 20 youths (16 to 35 years old) voluntarily participated in a series of four focus group discussions to assess their perceptions on egg utilisation. Commercial egg powder was used as a model for indigenous knowledge-processed egg powder to assess the food and nutrition security potential of egg powder using popular egg based dishes. The consumer acceptability of relish and sandwiches prepared with egg powder was evaluated using a consumer panel of 51 subjects recruited from survey participants. The nutritional composition of relish and sandwich prepared with egg powder was determined by the standard methods of the Association of Official Analytical Chemists (AOAC). Gross energy, protein, fat, fibre, total mineral content (ash) and selected individual minerals were determined. Market research assessing the accessibility of egg powder at a household level of Mkhambathini was conducted. A cost effectiveness analysis of producing egg powder at a household level compared to purchasing egg powder from commercial markets was evaluated. The same focus group discussions were used to assess the perceived benefits of producing egg powder at a household level.

The survey findings indicated that rural households in Mkhambathini were actively engaged in egg production, but poultry diseases and predation negatively affected egg production and productivity. The households had very limited or no access to modern egg storage and preservation technologies. As a result, the households lost a significant proportion of the eggs through spoilage. The rural households of Mkhambathini utilised eggs for food and several socio-cultural practices. The household perceived eggs as an important nutritious food source

as well as a highly valuable agricultural commodity for socio-cultural applications. The survey results indicated that eggs were used to prepare several dishes. Egg relish and sandwiches topped other dishes in terms of consumption. The overall acceptability of egg powder relish and sandwich was high and similar to that of fresh egg relish and sandwich. Thus, generally, commercial egg powder had no negative effects on the sensory properties of the relish and sandwich.

The nutritional composition of commercial egg powder and fresh egg was similar. The protein content of egg powder relish and sandwich was lower than that of the corresponding fresh egg products, however, it was nutritionally substantial. The results suggest that, in the form of relish and sandwich, commercial egg powder has a potential to improve the nutritional status of individuals who are at risk of having or have Protein-Energy Malnutrition. It was found that it would be cost effective for rural households in Mkhambathini to produce their own egg powder compared to purchasing the powder from commercial markets as they could utilise locally available resources. The production of egg powder at a household level could contribute to the frequent consumption of egg-based food products since egg powder will ensure the availability of eggs at all times. The increased utilisation of eggs would increase the demand for local eggs subsequently improving rural household livelihoods. Therefore, this study indicates that smallholder farmers and rural households could generate a profit from processing eggs into powder at household level. This could create opportunities for rural households to earn profitable cash income from selling either fresh eggs or egg powder or both.

The study results indicating the willingness of the rural households of Mkhambathini to try preserving eggs by processing them into powder and the observed high consumer acceptability of egg powder dishes prepared with commercial egg powder are encouraging as they highlight an opportunity to introduce egg powder as an egg preservation technique in rural Mkhambathini and other rural areas in similar socio-economic circumstances. Further research is therefore recommended to expand the consumer sample size and study area in order to increase the confidence of concluding these results for large rural populations.

## **PREFACE**

The work described in this dissertation was carried out in the school of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, from February 2014 to December 2014, under the supervision of Dr Unathi Kolanisi and Dr Mthulisi Siwela.

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As supervisors of the candidate we agree to the submission of this dissertation.

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Dr Mthulisi Siwela (Co-supervisor)

## **DECLARATION**

I, Sithandiwe Linda Khoza, declare that:

1. The research reported in this dissertation, except where otherwise indicated, is my original work.
2. This dissertation, or any part of it, has not been submitted for any degree or examination at any other university.
3. Where other sources have been used, they have not been copied and have been acknowledged properly.
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## CHAPTER 1 : STATEMENT OF THE PROBLEM

### 1.1 Introduction and background

Under-utilisation of food products which are rich in protein is a major challenge for rural households in Sub-Saharan Africa (SSA) (World Health Organization (WHO) 2009). As a result, the prevalence of Protein-Energy Malnutrition (PEM) is a major challenge in Sub-Saharan Africa (WHO) 2009). Protein-Energy malnutrition (PEM) is a form of under-nutrition whereby there is inadequate intake of energy and protein (Faber & Wenhold 2007; Raynaud-Simon *et al.* 2011). The high level of food and nutrition insecurity in rural areas of South Africa results from poor dietary intake because of food access constraints (Statistics South Africa (Stats SA) 2011). In South Africa, the KwaZulu-Natal province has the highest incidence of PEM (District Health Information Systems (DHIS) 2011) and it has been shown by SSA (2011) to be the second highest province with food access constraints (Cherian 2008).

Eggs seem to have the potential to mitigate the prevalence of PEM in rural areas because eggs are a good source of high quality protein, vitamins and minerals (Asghar & Abbas 2012; Bunchasak & Kachana 2009). Although eggs are essential for nutrition and health, the biggest disadvantage is that eggs are highly perishable with a shelf life of up to 14 days when stored at room temperature (Jirangrat *et al.* 2010). Since eggs are highly perishable and have a short shelf life they require a special preservation technique to extend their shelf-life and enhance easy storage. Rural households are faced with problems and challenges which hinder the production and consumption of eggs.

The utilisation of eggs as a source of protein is hindered by poultry diseases, lack of production inputs, lack of poultry management skills, lack of egg storage facilities and limited knowledge on egg preservation methods (Cherian 2008; Leta & Bekana 2010; Mutoyaba *et al.* 2011). Such challenges result in decreased egg yields for household consumption. Therefore, households resort to purchasing eggs instead of producing them (Mnyandu 2014). Most of the rural households have no or limited access to electricity, thus, cooling storage systems such as refrigerators that could extend the shelf-life of eggs are not accessible to rural communities (NPCS 2012). Further, these households are still faced with the geographical burden of being located in remote areas where there is poor infrastructure (Oraboune, 2008; Hendriks *et al.* 2009; Tshikosi 2009). Therefore, the issue of market access becomes a dominant challenge in such a situation due to inadequate roads and increasing egg and transportation costs which reduce the economic power of households to purchase eggs.

The distance from markets exacerbates the risk of eggs from breaking and affecting the quality of eggs. Therefore, egg powder as an egg preservation technique could address the above mentioned challenges. The rural households can use egg powder in place of fresh egg because it has a longer shelf life, nutrient dense and it is easy to store and transport (Rannou *et al.* 2013; Rao *et al.* 2012). However, the acceptability of egg powder to rural households who are not familiar with it may be a challenge. A study conducted in KwaZulu-Natal province by Mnyandu (2014) which assessed consumer acceptability of egg powder demonstrated a low acceptability of scrambled egg made from commercial powder compared to the fresh scrambled egg. The low acceptability was due to unfamiliar taste though colour was not much of a challenge. Nevertheless, it should be mentioned that the respondents showed willingness to adopt the egg powder preservation technique as they could get used to the unfamiliar taste. In addition, the findings of Mnyandu (2014) indicated consumer willingness not only to consume the egg powder but also to use it as a livelihood option intervention to create job opportunities for the unemployed youth.

In attempt to address the low acceptability of egg powder due to unfamiliar taste, egg powder could be processed into egg-based food products by adapting local recipes of egg-based dishes. Some of the ingredients of these dishes could mask the unfamiliar sensory properties of egg powder, including the unfamiliar taste reported by Mnyandu (2014). The consumer acceptability and nutritional composition of the egg powder food dishes should be assessed compared with corresponding traditional food dishes made with fresh egg to establish the consumer acceptability and nutritional impact of the egg powder dishes. A cost effectiveness analysis of either purchasing egg powder or processing egg powder at a household level is necessary for determining the economic feasibility of using egg powder in place of fresh eggs by rural households.

## **1.2 Importance of the study**

Eggs have potential to improve the nutritional status of individuals who are at risk of Protein-Energy Malnutrition in rural households of South Africa. However, the utilization of eggs as a source of protein is a major problem for rural households since eggs have a short shelf-life and rural households are not equipped with modern preservation technologies. Therefore, egg powder could be a feasible preserved food product which can address such a challenge due to its increased shelf-life, nutrient density and ease of transportation and storage. In addition, the challenges of egg transportation and egg storage in rural households can be minimised if an egg preservation technique is in place. Rural communities might be encouraged to consider

commercial egg powder purchasing and or adopt egg preservation technique for household consumption or entrepreneurial options. Such intervention could maximise the utilisation of eggs for food and nutrition security, open livelihood opportunities through entrepreneurship of making and selling egg powder or food products made from egg powder. Decision makers in agriculture (food security), social welfare and health (nutrition) could use this information to improve the food and nutrition security of households. To combat food and nutrition insecurity especially in rural areas, there is a need for a cost effective and locally-based intervention.

### **1.3 Aim of the study**

The aim of this study was to use commercial egg powder as a model to assess the potential of indigenous knowledge-processed egg powder to improve household food and nutrition security of rural households of Mkhambathini in KwaZulu-Natal province of South Africa.

### **1.4 Research objectives**

- To assess the utilisation of eggs in rural Mkhambathini.
- To determine the acceptability of food products prepared using commercial egg powder as a major ingredient by rural households in Mkhambathini compared with corresponding products made with fresh eggs.
- To evaluate the nutritional composition of food products prepared with commercial egg powder as a major ingredient compared with corresponding products made with fresh eggs.
- To determine the cost effectiveness of producing egg powder at household level compared to purchasing it from commercial markets, as well as rural entrepreneurship in egg powder.

### **1.5 Hypotheses**

The following hypotheses were tested in the study:

- There is no major difference in the nutritional composition of food dishes prepared with commercial egg powder and fresh egg.
- Egg powder food dishes are less acceptable compared to fresh egg food dishes, because of undesirable sensory properties resulting from high temperature processing.

### **1.6 Study limits**

The parameters of the study were as follows:

- Only commercial egg powder was used to prepare experimental dishes since egg powder prepared at household level is still under investigation. Egg powder processed at a household level using Indigenous knowledge could not be used because of safety concerns.
- The study was limited to households in rural Mkhambathini, namely: Maqongqo, Ophokweni and Abebhuzi village, who rear egg-laying chickens and consume egg based-food products. As a result, the findings of the study may not be applicable to areas other than Mkhambathini.
- The egg samples were only analysed for the following nutrients: Protein, fat, NDF (Neutral Detergent Fibre), ash, calcium, magnesium, potassium, sodium, phosphorus, zinc, copper, manganese and iron.

### **1.7 Assumptions**

The following assumptions were made:

- Commercial egg powder was used as a model for indigenous knowledge system (IKS) egg powder based on the assumption that the proposed (hypothesized) IKS processed egg powder would have similar quality attributes as commercial egg powder.
- The survey participants answered all questions honestly and without bias
- The focus group discussion participants gave honest responses about their perceptions
- The consumer panel for the sensory evaluation were free from sensory defects

### **1.8 Definition of terms**

#### Consumer acceptability

The degree of liking or disliking a food product based on the consumers sensory perceptions in terms of the products appearance, taste, aroma and texture (White and Prescott 2007).

#### Cost effectiveness

Cost effectiveness is the degree whereby benefits are worth the cost.

#### Egg powder

Egg powder is egg in powdered form which is fully dehydrated (Rao *et al.* 2012).

#### Egg recipes

Egg recipes are a set of instructions which describes how to prepare a food dish using eggs.



### Food and nutrition security

Food and nutrition security means the consumption and utilization of safe, adequate and quality food that is socio-cultural acceptable, should be available and accessible to be satisfactorily utilized (balanced diet and satisfactory nutrient absorption) by all at all times to live a healthy and happy life (McDonalds 2010).

### Nutritional composition

Nutritional composition was the amount and type of nutrients such as proteins, fats, carbohydrates, water, vitamins and minerals in food products (Belitz *et al.* 2009). In this study nutritional composition is limited to nutrients such as Protein, fat, NDF, ash, calcium, magnesium, potassium, sodium, phosphorus, zinc, copper, manganese and iron.

### Perceptions

A person's frame of reference emerging from previous experiences, beliefs, likes, dislikes, opinions, feelings and other psychological factors of unknown origin (Barrios and Costeil 2004).

## **1.9 Abbreviations**

CVD	: Cardio-Vascular Disease
DHIS	: District Health Information Systems
FAO	: Food and Agricultural Organization
FGDs	: Focus Group Discussions
NDF	: Neutral Detergent Fibre
IKS	: Indigenous Knowledge System
INP	: Integrated Nutrition Programme
PEM	: Protein-Energy Malnutrition
SSA	: Sub-Saharan Africa
Stats SA	: Statistics South Africa
WHO	: World Health Organization

## **1.10 Organisation of dissertation**

The dissertation is laid out as follows:

Chapter 1 provides the introduction and background to the research problem and the objectives investigated in this study. Chapter 2 reviews the literature on the food and nutrition security of rural communities in South Africa with reference to Protein-Energy Malnutrition (PEM), the role of eggs in human nutrition and health and egg powder preservation technique. Chapter 3 presents the study conceptual framework and description of the study area. Chapter 4 and chapter 5 are research chapters; chapter 4 presents results on egg production and utilisation in rural Mkhambathini, perceptions on egg utilisation and consumer acceptability of egg powder food products. Chapter 5 reports on the investigation of the nutritional quality of egg powder food products and the cost effectiveness of producing egg powder at household level compared to purchasing it from commercial markets. Chapter 6 presents the conclusions and recommendations.

## **1.11 Summary**

Access to adequate dietary intake is a major challenge for rural households in developing countries. As a result, there is a high prevalence of PEM which results from the imbalance between food intake and body requirements. In South Africa, the government has implemented nutrition interventions aimed at addressing undernutrition in the country. These nutrition interventions include the PEM scheme and the primary school nutrition programme. These nutrition interventions have not been effective, for various reasons. Eggs may have the potential to mitigate the prevalence of PEM in rural areas of the country, however, eggs have a short shelf life and they are highly perishable. Rural households are further not equipped with egg storage facilities and egg preservation methods hence eggs are lost through spoilage. Egg powder is a preserved food product which can be used in place of fresh egg because of its increased shelf-life, nutrient density, ease of transportation and storage. However, a previous study conducted in rural KwaZulu-Natal province demonstrated a low acceptability of scrambled egg made from commercial powder compared to the fresh scrambled egg. The low acceptability was due to unfamiliar taste though colour was not much of a challenge. Therefore, it appears essential to use various ingredients to mask the sensory attributes of egg powder and prepare egg-based food products which could possibly be accepted by rural households. There is a need to investigate the sensory acceptability and nutritional quality of food products prepared with egg powder as a major ingredient.

## **CHAPTER 2 : LITERATURE REVIEW**

### **2.1 Introduction**

Literature reviewed in this chapter covers the food and nutrition security status of rural communities in South Africa with reference to Protein-Energy Malnutrition (PEM). The nutritional composition of chicken egg and the importance of consuming eggs for nutrition and health are reviewed. Egg utilisation in rural households and the factors affecting food acceptability among consumers are also reviewed. Lastly, egg powder preservation techniques are reviewed and evaluated.

### **2.2 Protein-Energy Malnutrition (PEM)**

Malnutrition is defined as either under-nutrition (underweight, wasting and stunting) or over nutrition (overweight and obesity) (Joosten & Hulst 2008). Protein-energy malnutrition (PEM) is a form of under-nutrition whereby there is inadequate intake of energy and protein (Faber & Wenhold 2007). Raynaud-Simon *et al.* 2011 stated that PEM results from an imbalance between intake and body requirements. It is characterised by an increased vulnerability to infection that results from long-term consumption of insufficient energy and protein to meet dietary needs (Faber & Wenhold 2007). Although PEM is not instantly obvious and can only be detected by measuring different parameters of growth such as weight and height, children with severe PEM present clinical syndromes known as kwashiorkor and marasmus (Scrimshaw & Viteri 2008). PEM can also be observed in adults whereby it worsens the prognosis of underlying diseases (Raynaud-Simon *et al.* 2011). According to Grover & Ee (2009) Kwashiorkor tends to occur mainly in older infants and young children and it results from a diet with inadequate intake of protein. Marasmus commonly occurs in children younger than five years due to decreased caloric requirement intake coupled with susceptibility to infection (Grover & Ee 2009).

Malnutrition is the leading cause of death during childhood, resulting in more than 33% of child deaths worldwide (WHO 2013). According to Luchuo (2013) PEM has been observed most frequently in developing countries but it has also been described with increasing frequency in hospitalised chronically ill children in the United States of America. In Sub-Saharan Africa there was an increase in the percentage of underweight children from 11.7% to 13.5% between 1990 and 2010 (Lutter *et al.* 2011). In 2011, forty percent of children less than five years of age living in Sub-Saharan Africa were stunted (UNICEF 2013). The

prevalence of PEM in South Africa, a country in the Sub-Saharan Africa region, is reviewed in the next section

### **2.2.1 Protein-Energy Malnutrition (PEM) in South Africa**

South Africa as a middle-income country is faced with diet related diseases which are linked to under and over nutrition. The country is ranked in the top 20 countries with the highest burden of undernutrition whereby approximately 1 in 10 children is underweight and 1 in 5 is stunted with high levels in the rural areas of the country (Tathiah *et al.* 2013). The rise of diet related diseases in the country accounts for 28% of the burden of disease (Tathiah *et al.* 2013). The prevalence of protein-energy malnutrition in rural areas of the country is exacerbated by high levels of food insecurity. Food security is defined as a situation whereby all people at all times have economic and physical access to socially acceptable food in order to meet their dietary requirements (McDonalds 2010). In South Africa, food and nutrition security interventions are faced with a number of challenges, which are reviewed in the next section.

### **2.2.2 The conundrum of food and nutrition security interventions in South Africa**

According to Hendriks (2005) South Africa is deemed to be food secure at a national level however, at a household level many people are food insecure. FAO (2008) also stated that the majority of households in the country experience high rates of poverty and further lack appropriate resources and as a result dietary intake is inadequate. Access to food is a major challenge in the country. SSA (2011) demonstrated that provinces in the country are faced with inadequate access to food. The province of KwaZulu-Natal was found to be the second highest province with food access constraints. According to Faber & Wenhold (2007) inadequate dietary intake is increased by inadequate access to protein-energy rich foods. Jinabhai *et al.* (2003) argues that nutritional transition which is characterised by changes in patterns of food consumption is the major cause of undernutrition. A study conducted by Tathiah *et al.* (2013) in rural areas of KwaZulu-Natal demonstrated that undernutrition is a challenge for rural households. Malnutrition among female learners was assessed and the results demonstrated that 17.4% of the learners were underweight due to nutritional transition. The highest levels of stunting were observed in 11-12 year age groups while underweight was observed in 10 year age groups (Tathiah *et al.* 2013).

To improve the dietary intake of South African households, the South African government has implemented several nutrition interventions through the integrated nutrition programme

(INP) (Faber & Wenhold 2007). The nutrition interventions which are aimed at addressing undernutrition in the country with the highest budget allocation within the INP include the protein-energy malnutrition scheme and the primary school nutrition programme (Iversen *et al.* 2012a). According to Hendricks *et al.* (2003) during the initiation of the PEM scheme the main targets were children from six months to six years, in 1991 the scope of the target group was increased to accommodate vulnerable groups such as pregnant and lactating women, the aged and chronically ill. Later the scheme was integrated into the health facility to provide food supplements which are rich in energy and protein to vulnerable groups and the name of the scheme was changed to the nutrition supplementation programme. According to Iversen *et al.* (2012b) the scheme is now known as the nutrition therapeutic programme. The primary school nutrition programme was aimed at addressing short-term hunger and to improve active learning capacity through the provision of protein-energy rich diets in schools (Iversen *et al.* 2012a).

Iversen *et al.* (2012b) argues that both the programmes are faced with major challenges, such as inadequate management due to lack of capacity, inappropriate targeting, poor infrastructure in rural areas of the country and budgetary constraints. The failure of government nutrition interventions calls for self-reliance at a household level. Therefore, there is a need for a strategic focus which will enhance the food and nutrition security and livelihood options for rural households.

### **2.3 Proposed new strategic focus: food and nutrition interventions combined with livelihood options**

Government interventions aimed at ensuring food and nutrition security in South Africa have demonstrated a strong dependency syndrome with no guaranteed sustainability (Iversen *et al.* 2012a; Iversen *et al.* 2012b). There is a need for interventions which will encourage the utilisation of locally available resources in an attempt to address food and nutrition security while enhancing livelihood strategies for rural households. The adoption of egg powder as an egg preservation technique by rural households could ensure the availability of a protein rich food product at all times. Livelihood opportunities can be enhanced for rural communities through processing eggs produced locally within communities into egg powder for household consumption and entrepreneurship opportunities. The frequent consumption of egg-based food products in rural areas of South Africa could help reduce the prevalence of PEM since eggs are an important source of energy, high quality protein, carbohydrates, vitamins and

minerals (Schmier *et al.* 2009). Literature with regards to the nutritional composition and importance of eggs in human nutrition and health is further reviewed below.

### 2.3.1 The role of eggs in human nutrition and health

Table 2.1 illustrates the nutritional composition of a chicken egg

**Table 2.1: Nutritional composition of a chicken egg (Food Standards Agency (FSA) 2006)**

Nutrient	Nutrient content per 100g (Large egg)	Nutrient content per 52g (Medium egg)
Energy (Kcal)	151	78
Protein (g)	12.5	6.5
Carbohydrate (g)	Trace	Trace
Fat (g)	11.2	5.8
Cholesterol (mg)	391	225
Retinol equiv. (µg)	190	98
Vitamin D (µg)	1.6	0.9
Riboflavin (mg)	0.47	0.24
Folate (µg)	50	26
Vitamin B12 (µg)	2.5	1.3
Choline (mg)	160	83.2
Biotin (µg)	20	10
Phosphorus (mg)	200	104
Iron (mg)	1.9	0.99
Zinc (mg)	1.3	0.68
Iodine (µg)	53	28
Selenium (µg)	11	5.7

The shell of the egg is covered by a cuticle layer which is composed of approximately 90% of protein whereby there is a high content of glycine, glutamic acid, lysine, cysteine and tyrosin (Hai 2006). In addition, the membranes of the shell are made up of protein which has a high content of arginine, glutamine, methionine, histidine, cysteine and proline. The egg white and egg yolk both have different chemical composition in the whole egg. Egg white is composed of water, proteins, minerals, carbohydrates and lipids (FSA 2006). Water is the main

component of egg white accounting for about 87.8%, the second main component of the egg white is protein which accounts for 10.6% (Belitz *et al.* 2009).

Egg protein is of high nutritional value (Shebuski & Freier 2010). It is highly digestible and has a good amino acid profile. The main nutritive egg proteins are the albumins and globulins (Belitz *et al.* 2009). All the essential amino acids: histidine, leucine, lysine, isoleucine, threonine, tryptophan, methionine, phenylalanine and valine are present in the egg protein (Rodriguez 2005). According to Asghar & Abbas (2012) humans require proteins for building their body structures and eggs are capable of supplying amino acids which are essential for body development. Bologna *et al.* (2013) argues that eggs are composed of essential nutrients which increase resistance to diseases. To support such an argument, Belitz *et al.* (2009) also stated that eggs can provide essential portions of nutrients required daily for growth and maintenance of the body tissues

The various amino acids in an egg are essential for children, adolescents and young adults since protein is required to sustain growth and build muscle (Layman & Rodriguez 2009). Out of the nine amino acids, Layman & Rodriguez (2009) identified leucine as an essential amino acid which is capable of increasing energy using ability of muscles and helping muscles recovery after resistance and dynamic exercise in a human body. Likewise, Asghar & Abbas (2012) also stated that dietary protein in eggs is used by the human body to maintain and build muscular organs and other organs like the nerves, blood and bones. High quality protein can also prevent the degeneration of skeletal muscle and protect against some of the health risks associated with ageing (Thalacker-Mercer *et al.* 2007; Morais *et al.* 2006).

Herron & Fernandez (2004) noted nutrients in an egg which are required for normal development of the brain. These nutrients include choline, folate and selenium. Vitamin D, vitamin B12, choline, folate and selenium contribute to human health. According to Ruxton & Derbyshire (2009) vitamin D is capable of slowing down cell ageing and may also prevent Cardio-Vascular Disease (CVD), diabetes and cancer. Tamura & Picciano (2006); Wang *et al.* (2007) also stated that folate as a nutrient could prevent CVD and reduce the risk of stroke. Selenium provides protective effects in the early and latter stages of cancer (Zeng & Combs 2008) and also protect against lung cancer (Brinkman *et al.* 2006). Therefore, the presence of nutrients as mentioned in this section justifies that eggs are essential for human development and should be included in human diets.

Eggs have been largely criticised for increasing the risk of certain diseases due to the high cholesterol content. According to Spence *et al.* (2010); Djousse *et al.* (2009) and Barraj *et al.* (2009) egg consumption has been associated with the risk of cardiovascular disease (CVD), type 2 diabetes and heart disease. However, Schmier *et al.* (2009) found that eliminating eggs from the diet appeared to increase the risk of age-related diseases. A study conducted by Njike *et al.* (2010) suggests that dietary cholesterol has limited influence on serum cholesterol or cardiac risk. This suggests that egg consumption may to be non-detrimental to the endothelial function and serum lipids. Shin *et al.* (2013) conducted a meta-analysis and the findings suggested that egg consumption is not associated with increased risk of CVD and cardiac mortality in the general population. In addition, the study conducted by Djousse *et al.* (2010) demonstrated that there was no association between egg consumption and increased risk of type 2 diabetes.

#### **2.4 The production and utilisation of eggs by rural communities in Sub-Saharan Africa**

Rural households keep indigenous chickens for improving their livelihood opportunities (Hailemariam *et al.* 2010). In rural areas, indigenous chicken production is characterized by small size of unimproved flock per household and the chickens are maintained under scavenging regimes in backyards with minimal households providing supplementary feed (Albelqader *et al.* 2007). According to Mtileni *et al.* (2009) low input indigenous chicken production is very popular amongst resource limited rural communities of South Africa. Gender and age have been identified as major determinants of who manages poultry in rural areas. According to Dinka *et al.* (2010); Mtileni *et al.* (2009) chickens in rural areas are owned by women and children whereby the housing, feeding and general management of indigenous chickens are seen as the responsibility of women and children. A study conducted by Leta & Bekana (2010) in Ethiopia demonstrated that 92.4% of chickens were owned by females and children and they were responsible for rearing. Similarly, in Zimbabwe 95% of rural women were responsible for chicken rearing (Mapiye *et al.* 2008).

Poultry keeping plays a significant socio-economic role in rural households (Muhiye 2007). Chickens are capable of providing valuable animal protein in the form of meat and eggs. Chicken products are sold or battered to meet essential family needs and they are used in various traditional ceremonies (Alders & Pym 2009). Dinka *et al.* (2010) found that chicken keeping in Ethiopia was seen as a socio-economic benefit because households relied on it for household consumption, income and ceremonies. According to Aklilu *et al.* (2008) poultry keeping in Trigay was perceived as a protein source and means of generating income. It was



seen as a sense of self-reliance for women because egg sales are decided by women hence egg sales provide women with an immediate income to meet household expenses. A situational analysis in South Africa, KwaZulu-Natal province, demonstrated that approximately 77% of households reared indigenous chickens for meat and egg production (Tarwiyeri & Fanadzo 2013)

However, egg consumption in rural areas is highly associated with various perceptions and beliefs. Eggs are perceived in different ways by rural households. Eggs are viewed as a form of prestige (Moges *et al.* 2010), luxurious food commodity (Aklilu *et al.* 2010) and food commodity which should be consumed during periods of illness (Moges *et al.* 2010). As a form of prestige, rural households want to have more chickens as a result they leave chicken eggs to hatch. A study conducted by Moges *et al.* (2010) demonstrated that the highest proportion of eggs produced by rural households was hatched and remaining proportion of the eggs was consumed at a household level. This demonstrates that households value the possession of chickens as opposed to egg consumption. For an example, rural households in Zimbabwe value chickens over egg consumption due to the desire of having a large flock size (Alders & Pym 2009).

The consumption of eggs in rural households does not occur frequently, according to Molla (2010) eggs are perceived as essential food commodity which should be served to visitors and when household members are sick (Moges *et al.* 2006). Various beliefs hinder the consumption of eggs in rural households. Instead of consuming eggs, rural households leave eggs to hatch because it is believed that chickens are capable of appeasing or avenging spirits and ancestors when they are used for sacrificial offering (Mapiye *et al.* 2008). As a form of respect and sign of showing social good, chickens and eggs are given to visitors and relatives as gifts (Mapiye *et al.* 2008)

## **2.4.1 Challenges of egg utilisation**

### **2.4.1.1 Instability of production**

Egg availability at all times in rural areas is hindered by climatic conditions, inadequate feed intake and diseases. Egg production and egg quality in rural areas is affected by temperature. As Dandapat (2009) correctly stated, an increase in temperature above 28°C results in decreased production and quality of eggs. According to Leta & Bekana (2010) the limitation of feed resources is a problem which affects egg production. Gerber (2006) stated that the rise in temperature of 28°C to 32°C suppresses food intake of the hen hence resulting in decreased

availability of calcium and phosphorus for shell deposition and formation leading to thin shelled eggs. Supplementary feed is essential because it promotes health of eggs and chickens leading to increased flock size, high growth and fertility rates and chickens being less prone to diseases (Mapiye 2008).

Although indigenous chickens are well adapted to harsh environmental conditions (Leta & Bekana 2010), the mortality of chickens is most common during hot-wet and hot-dry seasons because chickens are more prone to diseases in such seasons (Muchadeyi *et al.* 2005). Alders & Pym (2009) stated that diseases are a major threat to egg production. For instance, small scale production of indigenous chicken in Zimbabwean households was characterised by low production due to diseases (Rusirevi 2013). According to Badhaso (2012) egg production in rural areas is characterised by lack of immunisation programs hence the risk of exposure to diseases is exacerbated. In South Africa, KwaZulu-Natal province, the failure to vaccinate chickens against poultry diseases is a major challenge for rural households (Tarwiyeri & Fanadzo 2013).

#### **2.4.1.2 Lack of access to housing and egg storage facilities**

Housing is essential to chickens because it provides shelter to chickens for egg laying (Dinka *et al.* 2010). However, rural households lack appropriate structures (Fisseha 2009). For instance, households in Ethiopia were reported to be using hand woven baskets and bamboo cages (Dinka *et al.* 2010). In South Africa, Tarwiyeri & Fanadzo (2013) demonstrated that only 34% of the households had poultry housing in KwaZulu-Natal province. The lack of housing structures results in a loss of egg laying chickens and eggs through predation. Most common predators include dogs, cats and snakes (Mapiye *et al.* 2008).

Lack of egg storage facilities is a major challenge for rural households. Eggs stored at room temperature results in egg spoilage hence storage facilities such as refrigerators are required to maintain egg quality (NPCS 2012). Egg storage time and temperature affects the quality of an egg, the changes that occur in a stored egg result in quality losses and nutritional value reduction (Olobatoke & Mulugeta 2012). Quality deterioration in an egg occurs when carbon dioxide and moisture is lost through shell pores. The study conducted by Olobatoke & Mulugeta (2012) demonstrated that low temperature storage during summer maintains egg quality. In general, low temperature is essential for maintaining egg quality.

### **2.4.1.3 Lack of access to markets**

Transport is an infrastructural constraint which hinders market access for both purchasing and selling egg products (Mapiye *et al.* 2008). Although farmers can produce, they do not have a transport system in place to transport their produce to markets (Kessides 2012). For instance, according to Rusirevi (2013) rural egg producers in Zimbabwe lack appropriate infrastructure for transporting eggs to markets. Similarly, in South Africa, rural households are faced with the geographical burden of being located in remote areas where roads are poorly developed (Thamaga-Chitja & Morojele 2014). Hence the failure of households to secure markets results to produce loss through spoilage.

### **2.4.2 Eggs in rural food dishes**

Eggs are extremely versatile and can be prepared alone or in combination with other foods (Brown 2014). Based on consumer's preference, eggs can be prepared as scrambled, omelette, relish or used in baked products. Various ingredients such as salt, spices, herbs, oil and sugar are used to enhance the savoury or sweet taste in an egg food dish. Egg dish preparation methods differ from culture to culture. The way in which food is prepared in households [during that period in time] is largely influenced by whether it's a normal day, religious or holiday celebration (Webb & Roten 2011).

During religious and holiday celebrations, households largely utilise eggs as ingredients in baked food products (Webb & Roten 2011; Tembo 2012). Eggs are capable of providing volume to the baked product, tenderness, structure, colour, flavour and nutritional quality (Kohrs *et al.* 2010). According to Webb & Roten (2011) during Christmas in Mozambique households bake *filhos de natal* (Christmas fritters) and *bolo polana* (Cashew nut and potato cake). In Tanzania households bake date nut bread and in Ghana they bake *gari* biscuits. However, baked products are not only prepared during religious and holiday celebration. In Ghana *Oto* which is a mixture of yam and eggs in a form of relish is a common meal used any time throughout the year. While on normal days eggs are largely utilised as relish. According to Tembo (2012) rural households in Zambia consume eggs as relish together with a staple meal called *Nshima*. In Kenya households prepare cabbage and egg as a relish served with a staple meal called *ugali*. On normal days, eggs are used in Ethiopia to bake *Injera*, an Ethiopian staple bread (Webb & Roten 2011).

## **2.5 Factors affecting food acceptability among consumers**

The foods itself as well as individual human beings have a huge influence on consumer acceptance of a food product. According to White and Prescott (2007); Siro *et al.* (2008) sensory attributes and psychological aspects of an individual play a major role in determining food acceptance.

### **2.5.1 Sensory properties**

The chemical and physical composition of a food product is perceived by an individual through sensory attributes which include taste, appearance, texture and aroma (White and Prescott 2007). Therefore, sensory quality is a key factor which determines food acceptance because consumers want a food product which meets their sensory requirements (Heldam 2004). According to Berry (2005) consumers evaluate a food product subconsciously beginning from the physical appearance and ending with mouth feel of the food product. Small and Prescott (2005) stated that the brain helps consumers to evaluate a food product because during food consumption, the brain is responsible for receiving different sensory inputs and interpreting those inputs to final sensory perception.

Rannou *et al.* (2013) argues that among the other sensory attributes, taste is the major determinant of whether a food product will be accepted or not. However, according to Sundquist *et al.* (2006) taste and odour determine the perceived flavour. Therefore, taste and odour of a food product would determine its acceptance. This implies that a pleasant or unpleasant odour from a food product may induce acceptance or rejection of the product (White and Prescott 2007). The perception of flavour is influenced by the individuals past experience with specific odour-taste combinations and also the cognitive factor that determines whether the flavour elements are well combined or not (Prescott 2004).

### **2.5.2 Consumer perceptions**

Psychological factors such as past experience, attitude, values and beliefs play a major role in determining the acceptance of a food product by consumers (Barrios and Costell 2004). Through their perceptions of sensory attributes and psychological aspect, consumers can either accept or reject a food product (Conner and Armitage 2002). Barrios and Costell (2004) stated that consumers attitude is driven by direct personal experience or information known about the product. Attitudes towards a food product can either be positive or negative. A negative attitude towards a food product can be changed once consumers are well informed about the value of the product, for instance, in terms of it being able to meet dietary needs

(Berry 2005). However, Siro *et al.* (2008) argues that the dietary benefits of a food product may provide added value to consumers but it cannot outweigh the sensory properties of the food product. Values and beliefs serve as guides for culturally appropriate behaviour regarding food choice and acceptance. People acquire a preference for food they have been exposed to in their cultures, therefore regularly consumed food tend to be preferred over new or unfamiliar food products (Oteku *et al.* 2006).

### **2.5.3 Sensory modification: Flavour enhancement**

Flavour enhancement is the addition of ingredients to improve food acceptance. Various ingredients are essential for modifying the taste, flavour and texture of a food product (Bayarri *et al.* 2006; Shan *et al.* 2007). Fat, salt, spices and herbs have been traditionally used as flavouring agents (Chung *et al.* 2003). Fat is very important for enhancing the flavour and texture of a food product. Most aroma compounds are fully or partly soluble in fat. This influences the mouth feel and intensity of perceived thickness in a food product (Bayarri *et al.* 2006). According to McCaughey (2007) salt is capable of enhancing the taste of some ingredients in a food product and also the masking of bitter or unfamiliar flavours. Similarly, Liem *et al.* (2011) argues that salt improves the sensory properties of a food product by increasing saltiness, decreasing bitterness and increasing sweetness. Spices and herbs are also capable of enhancing flavour in a food product which has an unfamiliar taste to the consumer (Shan *et al.* 2007).

### **2.6 Drying as an indigenous knowledge system technology (IKS) in rural areas**

Direct sun drying as a method of food preservation has been practised for many generations in rural areas (Bechoff *et al.* 2011). It has been used successfully to dry meat, cereals, fruits and vegetables by rural households (Sagar & Suresh Kumar 2010). The advantage of sun-drying is that it increases the shelf-life of dried food products and it is considered to be the least expensive food preservation method (Samad *et al.* 2009). However, it seems preservation of eggs by making egg powder at the rural community level is either not documented or is not practised. Rural communities could use the IKS drying technology (sun-drying) to preserve eggs for their improved food availability, accessibility and quality stability.

## **2.7 Egg powder**

### **2.7.1 The uses and methods of making egg powder**

Egg powder is eggs in powdered form which is fully dehydrated (Lechevalier *et al.* 2011). The use of processed egg products is on the increase. The food industry uses dried egg products as ingredients instead of traditional liquid eggs (Rao and Labuza 2012). According to Rannou *et al.* (2012) egg powder is mainly used in products such as bakery foods, bakery mixes, mayonnaise and salad dressing, confections, ice cream and pasta. Egg powder is preferred over traditional liquid eggs because it provides a convenient alternative to fresh eggs due to its nutritional and functional properties, increased shelf life and refrigerator not required for storage, easy transportation and handling and also its microbial safety (NPCS 2012). Food drying is not a new phenomenon; it has been practised successfully in drying of fruits and vegetables (Sagar and Suresh Kumar 2010). Egg dehydration can be achieved in different ways. Sperber and Doyle (2009) stated that among the most common methods of dehydrating an egg are spray drying, freeze drying and pan drying. Mnyandu (2014) demonstrated that sun drying can also be used as a method of egg dehydration.

### **2.7.2 Quality of egg powder**

Egg powder is high in protein, carbohydrate and energy (NPCS 2012), a 100g of egg powder contains approximately 55g of protein, 22g of carbohydrates and 450g calories. Egg dehydration eliminates the growth of micro-organisms in the egg product (Campbell *et al.* 2010). Sperber and Doyle (2009) argue that although egg dehydration minimises the presence of micro-organisms, some micro-organisms can survive the drying process and may be able to grow if the product is not packaged, stored and held in a manner that prevents water from entering the product. Table 2.2 summaries studies on the factors that affect the quality of egg powder.

**Table 2.2: A summary of studies on the factors which determine the quality of egg powder**

Author/s	How quality was evaluated	Parameters tested	Findings
Hammershoj <i>et al.</i> (2006)	Analysis of microbiological chemical and physical properties	-Fluidized bed system for dry pasteurization of egg albumen -Temperature (90°C vs 130°C) -High vs low air moisture at fixed temperature of 115°C	- The findings demonstrated that high temperature or high air moisture treatments ensured greater bacterial elimination. -However, the powder colour became darker and more yellow at high temperature and particle size increased.
Ndife <i>et al.</i> (2010)	The AOAC (1990) methods, the Furnace methods, the Kjeldahl methods were used to determine nutritional composition.	-Egg yolk powder & Egg white powder vs whole egg - Oven drying (temperature 44°C)	- Results indicate that the oven drying method used had an effect on some of the functional properties of the dried egg components. - For instance, egg yolk powder had better emulsification capacity (74%) and stability (72.4%) compared to whole egg (55 and 44.86%) and egg white powder (17.77 and 14.70%). While the egg white powder gave better foam stability (78.3%) and capacity (97.5%) compared to whole egg (59.28 and 40.0%) and egg yolk (28.08 and 38.5%) powders. -The nutritional composition determined, showed high values when compared to that of fresh eggs. This is an indication that the drying temperature of 44°C did not adversely affect the nutritional value of the oven dried egg components.
Kumaravel <i>et al.</i> (2012)	The AOAC (2005) methods were used in determining nutritional properties	-Whole egg vs egg powder -Vacuum oven drying (temperature 44°C)	-The drying temperature did not adversely affect the nutritional value of oven dried egg components. -Results demonstrated that egg powder had higher values for nutritional composition when compared to that of fresh eggs. -The increase of carbohydrate in the egg powder produced through vacuum technology had a visible proof of increased shelf life which indirectly reduces the risk of caramelization.

Author/s	How quality was evaluated	Parameters tested	Findings
Rao <i>et al.</i> (2012)	Analysis of physicochemical properties	<ul style="list-style-type: none"> <li>-Dried egg whites vs hydrolysed egg whites</li> <li>-Storage quality (45°C vs 25°C for 2 months)</li> <li>- Water activity (0.05-0.79)</li> </ul>	<ul style="list-style-type: none"> <li>- The effect of water activity on the colour change of hydrolysed egg powder at 45°C for one month was similar to that of hydrolysed egg powder at 23°C for four months due to the presence of glucose.</li> <li>- Several structural changes occurred at water activity from 0.43-0.79 including agglomeration, stickiness and collapse.</li> <li>-There was a high correlation between colour change and fluorescence, as expected for the maillard reaction. Therefore, this means that during storage, the maillard reaction and/or its resulting products could decrease the nutritional value and quality of hydrolysed egg powder.</li> </ul>
Rannou <i>et al.</i> (2013)	Sensory analysis using free sorting (35 untrained judges) and Gas chromatography couples to mass spectrometry and olfactometry	<ul style="list-style-type: none"> <li>-Whole egg vs egg yolk</li> <li>-Polyunsaturated fatty acid (PUFA) enrichment</li> <li>-Spray drying temperature (160 °C vs 180 °C)</li> <li>-Production scale (industrial vs pilot plant)</li> <li>-Storage temperature (15 °C vs 30 °C)</li> <li>-Time (1, 2, 4 &amp; 8 months)</li> </ul>	<ul style="list-style-type: none"> <li>-Spray drying temperatures did not affect the odour of egg yolk powders</li> <li>-There was a significant difference between odour of whole egg and egg yolk powders as well as the powders produced in an industrial scale and pilot plant</li> <li>-An increase in the odour intensity of egg powders was observed during storage</li> <li>-Unpleasant odours were perceived when egg powders were stored at 30°C</li> </ul>
Mnyandu (2014)	Analysis of microbial quality and safety of dried eggs looking at the Total Plate Count, <i>Coliforms</i> , <i>E. coli</i> and <i>Salmonella</i> . This was determined according to SABS ISO standards methods	<ul style="list-style-type: none"> <li>-Sun dried vs oven dried eggs</li> <li>- Oven drying temperature (35 °C)</li> <li>-Sun drying (72h)</li> </ul>	<ul style="list-style-type: none"> <li>- When observed over a period of 8 weeks, both sun-dried and oven-dried eggs developed a rancid flavour</li> <li>- However, the microbiological analysis results showed that the egg powders met the standards for egg quality and safety as indicated by their levels of <i>Salmonella spp.</i>, <i>E. coli</i>, <i>Coliforms</i>, <i>Listeria monocytogenes</i>, and Total Plate Count. Therefore, this means that samples had little or no growth of these microorganisms suggesting that they were safe for consumption</li> </ul>



Although egg powder has an increased shelf-life, the research findings summarised in Table 2.2 demonstrate that the type of dehydration method, the temperature of dehydration, production scale, storage temperature and storage period will determine whether egg powder will be of good quality or not. The drying temperature demonstrated to be capable of eliminating micro-organisms which can cause health risk and food spoilage. For instance, Mnyandu (2014) indicated that egg powder dehydrated using oven and sun drying had little or no growth of microorganisms. In addition, the drying temperature at 44 °C using the oven drying method did not affect the nutritional value of oven dried egg powder hence egg powder had high nutritional value compared to fresh egg (Kumaravel *et al.* 2012; Ndife *et al.* 2010). However the dehydration method used has indicated to have an effect on the functional properties of egg powder. For instance, according to Ndife *et al.* (2010) the oven drying method had an effect on the functional properties of dried egg components such as foam stability and emulsification capacity. However, NPCS (2012) showed that the functional properties of egg powder were not adversely affected by drying. During dehydration and prolonged storage of egg powder minor nutrient loss could occur (Campbell *et al.* 2009). Therefore, the nutritive value of egg powder would practically be the same as the fresh egg if stored properly (NPCS 2012).

The type of production scale together with the production method, production temperature and storage is a major determinant of egg powder odour and colour. For instance, Mnyandu *et al.* (2014) assessed the feasibility of making egg powder at household level and when observed over a period of 8 weeks, both sun dried and oven dried egg powder developed a rancid colour. Similarly, when a fluidised bed system for dry pasteurisation of egg albumen was used, the powder colour became darker and more yellow at high temperature and particle size increased (Hammershoj *et al.* 2006). In addition, Rannou *et al.* (2013) observed that there is an increase in the odour intensity of egg powders during storage. Unpleasant odours were perceived when egg powders were stored at 30 °C. The quality of egg powder can be maintained if moisture content is low and if it is stored in air tight sealed containers (NPCS 2012). To ensure an increased egg powder shelf-life, appropriate precautions need to be taken before production, during production and after production.

### **2.7.3 Consumers acceptance of commercial egg powder**

Studies conducted on consumer acceptance of commercial egg powder clearly demonstrate that the acceptance of egg powder is highly influenced by sensory attributes. Table 2.3 summarises studies on the consumer acceptance of commercial egg powder.

**Table 2.3: A summary on consumer acceptance of commercial egg powder**

Author/s	Type of study	Study area	Food tested	Findings
Kalaikannan <i>et al.</i> (2007)	Sensory evaluation and experiment	Indian veterinary research institute	Chicken patties with whole egg powder (WEP), dried albumen (DA), dried yolk (DY) and liquid egg (LE)	<ul style="list-style-type: none"> <li>-Addition of WEP and DA improved the appearance and colour scores of chicken patties.</li> <li>-Addition of dried egg powders enhanced the flavour of chicken patties .</li> <li>-The juiciness and texture of the chicken patties were improved by addition of WEP, DA, DY and LE. Hence this increased the overall acceptability of chicken patties.</li> </ul>
Kohrs <i>et al.</i> (2010)	Consumer acceptance test (104 untrained consumers)	Kansas State University	Yellow cake made with whole egg powder (WEP) and egg replacers (Xanthan/whey protein isolate/wheat starch)	<ul style="list-style-type: none"> <li>-The cake made with WEP was significantly more yellow than the cake made with egg replacers. However, the cake made with WEP was less favourable in terms of appearance, texture, flour and overall acceptability.</li> <li>-The panellists stated that the cake made with WEP was drier and needed more flavour. However, 54% indicated that they are willing to purchase the cake made with whole egg powder while 70% indicated that they would purchase the cake made with egg replacers.</li> </ul>
Muthia <i>et al.</i> (2012)	Sensory evaluation (25 panellists) and experiment	University of Sains, Malaysia	Duck sausages prepared using sago flour & tapioca flour (with/without egg powder)	<ul style="list-style-type: none"> <li>-Duck sausages prepared using tapioca or sago flours together with EWP increased overall acceptability and improvement in texture, elasticity, and colour. However, had no effect on flavour, taste, and juiciness.</li> <li>-There was a significant increase in protein content, folding test, cooking yield, water holding capacity, moisture and fat retention in duck sausages prepared using flours combined with egg white powder.</li> </ul>
Mnyandu (2014)	Sensory evaluation (63 panellists) and focus group discussion	Impendle, KwaZulu-Natal province, South Africa	Scrambled commercial egg powder and scrambled fresh egg	<ul style="list-style-type: none"> <li>- Results demonstrated that fresh eggs had better scoring on all attributes (appearance, aroma, taste, colour and overall acceptability).</li> <li>- The panellists commented that the scrambled egg powder had an unusual aroma, which was not present in the scrambled fresh egg, hence the scrambled fresh egg was the most preferred.</li> <li>- Consumers demonstrated willingness and eagerness to learn about egg powder.</li> </ul>

Findings summarised in Table 2.3 indicate that, generally, egg powder is not preferred by consumers. Sensory characteristics are the major cause for poor acceptance of egg powder. The sensory perceptions of consumers have been demonstrated to be influenced by past experiences and individual preferences. For instance, egg powder was more acceptable when it was used to prepare chicken patties; however, it was not accepted when it was used in duck sausages. Oteku *et al.* (2006) argues that such a situation can be linked to the fact that duck sausage is a new processed meat product and duck meat product consumption is very low compared to chicken meat. Similarly, Mnyandu (2014) found that the flavour of fresh egg was more acceptable to the panellist than that of egg powder. This can be linked to the fact that consumers are used to consuming fresh eggs (Hailemariam *et al.* 2010) and egg powder is a new product to them. Although consumer acceptance of egg powder is highly influenced by sensory attributes of the product, consumers' willingness and eagerness to learn about egg powder (Mnyandu 2014) together with the willingness to purchase products made using egg powder (Muthial *et al.* 2012) makes it very essential to mask the taste of egg powder and explore other food products in which egg powder will be more acceptable to ensure rural household food security.

#### **2.7.4 Egg powder as an opportunity for rural household food and nutrition security and livelihood options**

Egg powder appears to be the most feasible product which can be utilised by rural households to ensure stability and availability of a protein rich food product at a household level. Rural households are faced with various challenges which hinder egg consumption. Amongst the others, the lack of cooling facilities in rural areas results into egg spoilage due to prolonged storage at room temperatures. According to Rao and Labuza (2012) apart from its nutritional advantages, eggs powder is characterised with easy storage, transportation and handling. The instability of egg supplies in rural areas calls for the use of an already preserved egg product to ensure stability. The use of egg powder has the potential to contribute positively to the millennium development goals hence impacting positively on household food security. Table 2.4 demonstrates the possible contributions of egg powder to millennium development goals and beyond.

**Table 2.4: Possible contribution of egg powder to the millennium development goals and beyond.**

Millennium development goal	Possible contribution
1:Eradicating extreme poverty and hunger	Availability at all times of egg products in rural households will be ensured by the use of egg powder.
4:Reduce child mortality	Egg powder has high quality nutrients hence the prevalence of protein-energy malnutrition in rural households will be minimised.
5:Improve maternal health	

The proven possibility of making egg powder using the sun drying method at a household level by Mnyandu (2014) calls for appropriate education and training on egg powder production for rural households. The majority of individuals are unemployed in the rural areas of South Africa (Tathiah *et al* 2013). Therefore, household produced egg powder could have the potential to be used in place of fresh egg and as a livelihood opportunity for rural households. Households can produce their own egg powder for household consumption and income generation.

## 2.8 Summary

Eggs are capable of supplying nutrients which are essential for human development. However, eggs are highly perishable and they have a short shelf life. As a result, eggs require a special preservation technique. Egg powder is egg in its preserved form which could be used to improve the nutritional status of individuals at risk of PEM. Egg powder produced at a household level could be utilised as an alternative to fresh egg since it has an increased shelf life, high nutrient density and it is easy to store and transport. However, the acceptance of commercial egg powder has been reported to be highly influenced by sensory attributes. Therefore, it would be very important to investigate the acceptance of commercial egg powder in other food forms as a model for household produced egg powder and further assess the nutritional quality of these foods

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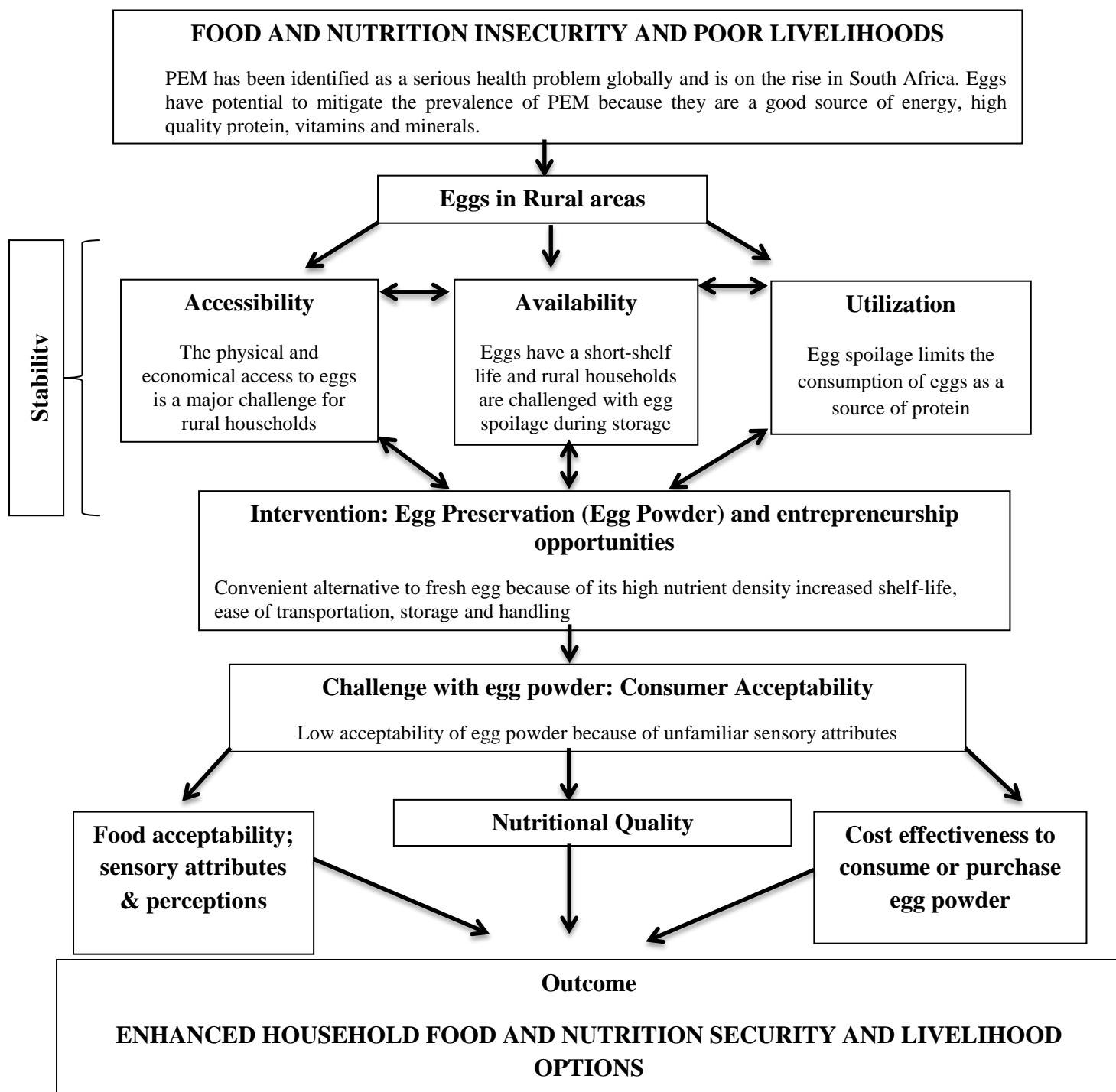
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### **CHAPTER 3 : STUDY CONCEPTUAL FRAMEWORK AND DESCRIPTION OF THE STUDY AREA**

As presented in section 1.2 of this study, eggs have potential to mitigate the prevalence of PEM in rural areas of South Africa. Yet, eggs in rural areas are underutilised due to various reasons including lack of egg storage, fresh egg short shelf-life span and limited knowledge of modern preservation techniques. Egg powder could be a feasible egg preservation technique which could improve food and nutrition security while creating wealth creation opportunities for improved rural household livelihood options. Figure 3.1 shows the study conceptual framework.



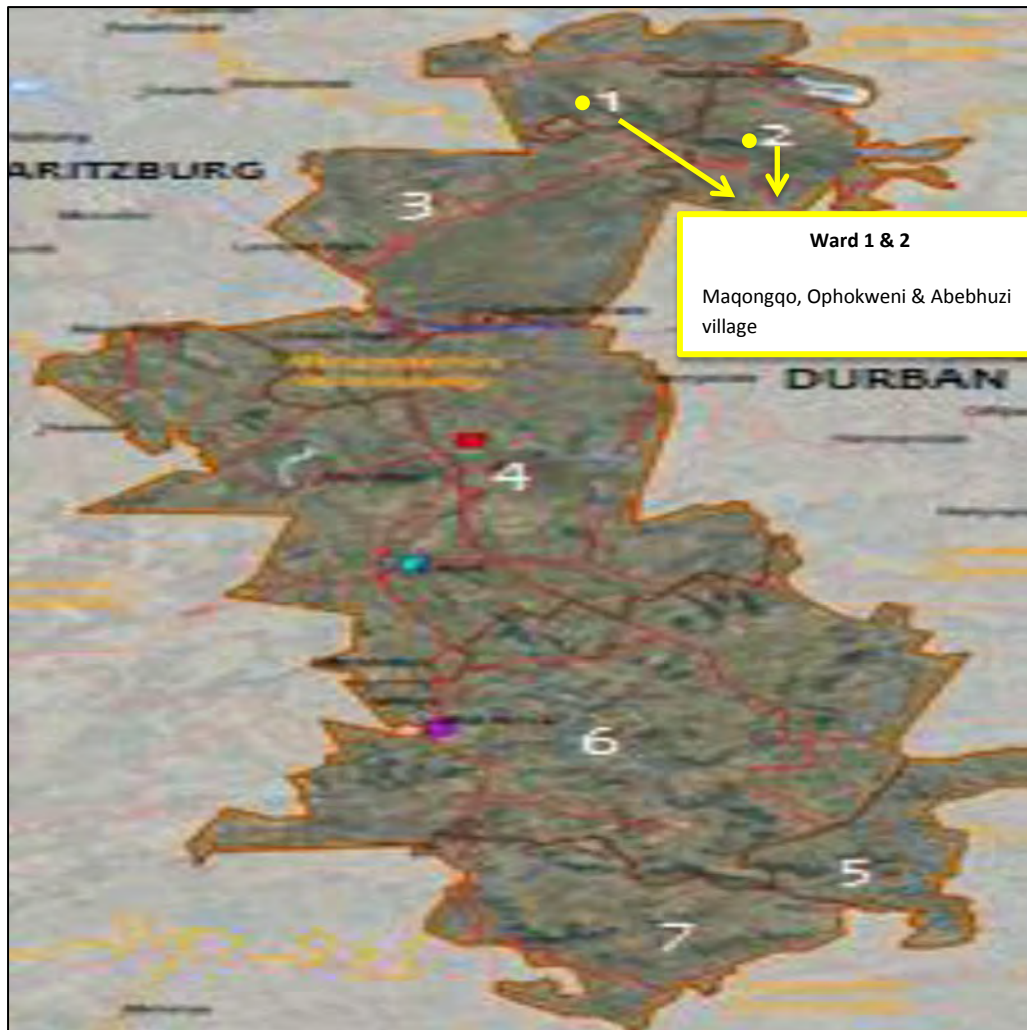
**Figure 3.1: Study conceptual framework**

### *Description of study area*

Mkhambathini local municipality lies about 20km east of Pietermaritzburg, the capital city of KwaZulu-Natal, South Africa. As the second smallest municipality within uMgungundlovu district municipality, it covers an area of 917 km<sup>2</sup> (IDP 2013). It is situated along the south-eastern boundary of uMgungundlovu district municipality and it adjoins Richmond and Msunduzi local municipalities to the west, uMshwathi to the north and eThekweni metropolitan to the east. Figure 3.2 shows the location of Mkhambathini Municipality in KwaZulu-Natal province and Figure 3.3 shows a map of Mkhambathini Municipality wards.



**Figure 3.2: Map of Mkhambathini Municipality and surrounding areas (IDP 2013)**



**Figure 3.3: Map of Mkhambathini Municipality showing wards (IDP 2013)**

Mkhambathini local municipality consists of seven wards with a large part of the municipality being rural in nature and underdeveloped (Mkhambathini local municipality 2007). The population of Mkhambathini local municipality is unevenly distributed in the seven wards and is slightly imbalanced with females out-numbering their males counterparts. It represents over 6.7% of the population of UMgungundlovu district municipality with the majority of the population being black South Africans (Lehohla 2012). About 51% of the population consists of the working age group individuals aged between 20 and 60 years, 41% of the population accounts for school age population and 8% accounts for individuals older than 60 (IDP 2013).

This research was only conducted in ward one and ward two, targeting three villages namely Maqongqo, Ophokweni and Abebhuzi village. The three villages were chosen because they are situated close to the residences of traditional leaders and their households typically represent the resource-poor and low income rural households of the Mkhambathini local



municipality. The high rates of income poverty in the municipality are a result of high rates of unemployment and poor access to productive resources (Mkhambathini local municipality 2007). According to Mkhambathini local municipality (2007), a large number of Mkhambathini residents depend on the agricultural sector for employment. This indicates a continued dependency on employment opportunities in the primary sector of the economy. About 1354 households do not have any form of income and 6760 households have an income below R22 728 per annum. Therefore, they are regarded as living below the poverty line (Lehohla 2012). Human poverty in the municipality is influenced by the increasing rates of illiteracy, food insecurity and malnutrition (IDP 2013). This indicates that there is a need for innovative technologies which would enhance food access for households in rural Mkhambathini.

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## **CHAPTER 4 : UTILISATION OF EGGS AND CONSUMER ACCEPTABILITY OF EGG POWDER RELISH AND SANDWICH BY RURAL HOUSEHOLDS OF MKHAMBATHINI**

### **4.1 Abstract**

The aim of this study was to explore the utilisation of eggs in rural Mkhambathini and assess the consumer acceptability of food products made with commercial egg powder. A total of 110 household representatives participated in the survey. A survey questionnaire was administered to collect information on egg production, storage and utilisation. From the survey participants, 20 adult women and 20 youths (16 to 35 years old) voluntarily participated in a series of four focus group discussions (FDGs) to assess their perceptions on general egg utilisation. A consumer panel of 51 subjects was recruited from the survey participants to assess the sensory acceptability of food products (relish and sandwich) prepared with commercial egg powder. The study findings showed that rural households in Mkhambathini were engaged in egg production, however, poultry diseases and predation hindered the effective production and productivity of eggs. The households indicated that they had no or very limited access to modern egg storage facilities and hence egg spoilage was a major challenge. The rural households viewed eggs as a nutritious food product, which should be included in their diets. The households utilised eggs for several purposes, viz various food dishes and socio-cultural applications. Egg relish and sandwich were found to be the most commonly consumed amongst the popular egg-based dishes. Generally, commercial egg powder had no negative effects on sensory properties of egg relish and sandwich. The overall acceptability of relish and sandwich prepared with commercial egg powder was high and similar to the relish and sandwich prepared with fresh egg. Therefore, rural households can use egg powder produced at a household level in place of fresh eggs when preparing relish and sandwiches to improve their food and nutrition security.

### **4.2 Introduction and background**

Although South Africa is a developing country with a good economical standing, it has challenges of economic inequalities and is faced with malnutrition, under- and over-nutrition. According to Faber and Wenhold (2007), protein-energy malnutrition (PEM) is a reality for rural households in South Africa. PEM is a form of under-nutrition, whereby there is inadequate intake of energy and protein which results from an imbalance between intake and body requirements (Raynaud-Simon *et al.* 2011). Tathiah *et al.* (2013) demonstrated that under-nutrition, including PEM, is a major challenge for rural households in KwaZulu-Natal

province. The prevalence of PEM in rural areas of South Africa is exacerbated by high levels of food insecurity. Food insecurity is defined as the lack of economic and physical access to food which is nutritious and socially acceptable in order to meet dietary requirements (McDonalds 2010). Food access is a major determinant of adequate dietary intake and it is a major challenge in South Africa. Statistics South Africa (SSA) (2011) indicated that the province of KwaZulu-Natal province was the second highest with regard to food access constraints.

Rural households in Africa keep indigenous chickens for both meat and egg consumption (FAO 2013). Eggs are essential for human development as they are a good source of energy, high-quality protein, vitamins and minerals. However, eggs have a short-shelf life and are highly perishable. Households are also faced with various challenges which hinder the utilisation of eggs as a source of protein. Poultry diseases, seasonality of egg production, poor egg storage facilities and limited knowledge of how to preserve eggs result in decreased egg consumption (Cherian 2008). Mnyandu (2014) demonstrated that egg production constraints at a household level forced households to source eggs from commercial markets. This poses challenges to the food security of South African rural households, because the rural areas have a poor transport infrastructure and are located far away from the commercial markets, which are generally found in urban and peri-urban areas. Thus these rural households experience both physical and economic market access problems due to the poor transport system and high transport costs (Oraboune 2008). Furthermore, the long distance from markets exacerbates the risk of eggs breaking and deteriorating in quality.

To improve the food and nutrition security of South African households, the South African government has implemented several nutrition interventions through the Integrated Nutrition Programme (INP) (Faber and Wenhold 2007). Between 1994 and 2010, the nutritional interventions aimed at addressing malnutrition for the resource-poor communities in South Africa have been a failure (Iversen *et al.* 2012b). The PEM scheme and the primary school nutrition programme had the highest budget allocation within the INP (Iversen *et al.* 2012a). However, both programmes were faced major with challenges, including inadequate management due to lack of capacity, inappropriate targeting, poor infrastructure in rural areas and budgetary constraints (Iversen *et al.* 2012b). Therefore the 16 years of failure of government nutrition interventions calls for self-reliance at the household level to increase household food and nutrition security. Egg powder could be a feasible product that can

provide a convenient alternative to fresh egg for South African rural households due to its high nutrient density, long shelf-life and ease of transportation, storage and handling (Rannou *et al.* 2013). Egg powder has almost the same nutritional value as fresh eggs, but the nutrients are more concentrated in the egg powder (NPCS 2012).

Egg powder could improve the food and nutrition security of South African rural households; it would particularly contribute to the alleviation of PEM. Rural households could source the egg powder from the commercial markets or process the eggs produced by their chickens into powder, using appropriate technologies such as solar and sun-drying, which have been proposed previously (Mnyandu 2014). Unfortunately, it seems that rural households, especially those in Mkhambathini, KwaZulu-Natal, the rural area chosen for the current study, do not know about egg powder and are not currently utilising it. Since these households are accustomed to egg-based food products prepared with fresh eggs, food products prepared with egg powder may not be acceptable to them, but this has not been investigated. A study conducted by Mnyandu (2014) revealed that rural households in Impendle were not familiar with egg powder, hence the lower acceptability of scrambled egg prepared with commercial egg powder relative to the scrambled egg made with fresh eggs. Thus the findings of Mnyandu (2014) indicated that there was a need to improve the acceptance of commercial egg powder by the rural households surveyed. The low acceptance of egg powder may be resolved by masking the sensory properties that cause it to be less acceptable than fresh eggs. Egg recipes with the masking effect need to be determined through research.

The objectives of this study were to assess the utilisation of eggs by rural households of Mkhambathini, KwaZulu-Natal, South Africa, and determine the sensory acceptability of food products prepared with commercial egg powder as a major ingredient.

### **4.3 Research methodology**

#### **4.3.1 Research technique**

A mixed research methodology was used for the study, i.e. both quantitative and qualitative methods were used. According to Teddlie and Tashokkori (2009), a mixed research methodology is used to answer research questions which a single methodology cannot answer; this methodology was found appropriate for this study because the study aimed to

find answers for a variety of questions, which included socio-economic, psychological and technical questions.

#### **4.3.2 Sampling technique**

The study was conducted in three parts: a survey, focus group discussions and sensory evaluation. The criteria for including households from the three selected villages (Maqongqo, Ophokweni and Abebhuzi) in the study were that they were engaged in egg production, were consumers of egg-based food products and were volunteering to participate in the study. Key informants were used to identify the households engaged in chicken rearing. Volunteers were randomly selected from the sample frame provided by the key informants to participate in the survey. A total of 110 household representatives participated in the survey. For focus group discussions and sensory evaluation, purposive sampling and quota sampling were used. From the survey participants, a purposeful quota sample of 20 adult women and 20 youths participated in a series of four focus group discussions and 51 subjects were randomly selected to participate in sensory evaluation.

#### **4.3.3 Research procedure**

##### **Survey**

A survey questionnaire was first formulated in English (Appendix A) and then translated into IsiZulu (Appendix B). The questionnaire written in isiZulu was administered to 110 respondents seated apart from each other to avoid sharing of views between them. Trained field workers assisted illiterate respondents to fill out the questionnaire. The questionnaire was made up of 39 questions, which inquired about ownership of chickens, ways of acquiring eggs for consumption, the options the rural households had for utilising eggs and methods used to store and preserve eggs.

##### **Focus group discussions**

A series of four focus group discussions were conducted in the study area to determine the perceptions on egg utilisation by rural households of Mkhambathini. The focus group discussions were conducted following a focus group discussion guide and they were facilitated by field workers who were fluent in IsiZulu. The focus group discussion guide was first formulated in English (Appendix C) and then translated into IsiZulu (Appendix D). The participants of the focus group discussions were recruited on a voluntary basis from the survey participants. In order to obtain different perceptions from different age groups, the

participants were divided into two demographic groups, youths and adult women. Each focus group discussion was made up of eight to twelve participants. A digital video camera was used to record the focus group discussion sessions. The recorded data was transcribed into text. The transcribed text, together with hand written notes were used to generate the main findings of the focus group discussions.

## **Sensory evaluation**

### *Sensory evaluation panellists*

A total of 51 panellists from rural Mkhambathini participated in the sensory evaluation. Participation in the sensory evaluation was on a voluntary basis and the sensory evaluation participants were recruited from the survey participants. The individuals who were willing to participate were randomly selected from the list of volunteers by field workers.

### *Preparation of the egg sample*

Commercial egg powder and commercial fresh egg (the control) were used to prepare two types of egg dishes which were mostly preferred by rural households of Mkhambathini, a relish and a sandwich. The egg dishes were prepared using recipes which were obtained from the community (Appendix E and Appendix F). To ensure that the egg dishes were culturally acceptable to the participants, the egg dishes were prepared in the research site by two women from the community with experience of processing the recipes. The women were trained on how to reconstitute egg powder following a method described by Ross (2008).

### *Sample coding, serving order and sensory evaluation set-up*

To reduce bias associated with the labeling of samples, a table of random numbers was used to assign each sample a unique three-digit code. The samples were tested in randomised order from left to right. Randomisation of the serving order was done using a Table of Random Permutations of Nine. To prevent the panellists from influencing each other's responses, the sensory evaluation panellists were made to sit far apart. All participants were provided with a glass of water, plastic teaspoon, serviette, small dish containing approximately 5 g of each egg dish and the sensory evaluation questionnaire written in isiZulu (Appendix H). The English version (Appendix G) of the sensory evaluation questionnaire was translated into IsiZulu. The sensory evaluation questionnaire was in the form of a five point facial hedonic scale (1=very bad; 5=very good) in order to accommodate illiterate individuals.

Before starting the sensory evaluation, participants were required to fill in a consent form. The consent form was formulated in English (Appendix I) and then translated into IsiZulu (Appendix J). The researcher provided an explanation of the consent form in IsiZulu to ensure that participants understood everything before signing the form. After the consent form was signed, field workers provided an explanation of the sensory evaluation questionnaire. The panellists were asked to rate the acceptability of each sensory attribute of the egg samples by marking an 'X' on the face which best suited the sensory acceptability of the attributes of each sample. Illiterate participants were further assisted by field workers if they required more assistance to fill out the questionnaire.

#### **4.4 Validity and reliability of methods**

A pilot study was conducted prior to the main study, using a small sample of the households from the study area. The pilot study was conducted to test the study methodology and modify it if necessary. The methodology was modified to refine it and some survey and sensory evaluation questions were revised. For the survey, trained field workers were used to administer the questionnaire, which was translated from English to isiZulu by two field workers who were proficient in both English and isiZulu (local language). Focus group discussions were conducted by a trained facilitator who was fluent in isiZulu. Sensory evaluation panellists were asked to fill in a consent form before the evaluation session. A research assistant was available to explain the consent form in detail in isiZulu. The 5-point pictorial hedonic scale was translated to isiZulu and had smiley faces to accommodate the less illiterate panelists. All the sensory attributes in the 5-point pictorial hedonic scale were explained to the panellists. Ethical clearance was obtained from the University of KwaZulu-Natal research office, since human subjects were used in the study.

#### **4.5 Data analysis**

The Statistical Package for Social Sciences (IBM SPSS), version 21, was used to analyse quantitative data and descriptive statistical analysis was performed. Focus group discussions were analysed by linking themes, concepts, patterns and quotes which emerged from the discussions with the relevant literature.

#### **4.6 Ethical considerations**

The ethical approval to conduct the study was obtained from the University of KwaZulu-Natal, Humanities and Social Science Research Ethics Committee (HSS/0718/014M) (Appendix K). Approval to conduct the study in rural Mkhambathini was obtained from



Mkhambathini Municipality issued by the community services manager (Appendix L). The sensory evaluation panellists were required to sign a consent form (Appendix I) before participating in the sensory evaluation, the consent form was clearly explained in IsiZulu to accommodate illiterate individuals.

## 4.4 Results and discussion

### 4.4.1 Respondent demographic profile

The demographic profile of survey sample is indicated in Table 4.1

**Table 4.1 : Respondents demographic profile (n=110)**

Gender	Age	Level of education	Employment status	Household income (Rands/month)
Male 13 (12%)	16-25 29 (26%)	No education 8 (7%)	Unemployed 50 (46%)	Below 800 47(43%)
Female 97 (88%)	26-35 51 (46%)	Primary 21 (19%)	Part-time 59 (54%)	800-1500 45 (41%)
	36-45 14 (13%)	Secondary 69 (63%)	Full-time 1 (0.9%)	1500-3500 12 (11%)
	46-55 12 (11%)	Tertiary 12 (11%)		Above 3500 6 (6%)
	56-65 4 (4%)			

There were many more females than males. The age of the respondents ranged from 16 to 65 years and the majority of respondents were in the 26 to 35 age range, whilst the minority of respondents were in the 56 to 65 age range. A small proportion of the respondents had no formal education, whilst the majority had received secondary school education. The majority of the respondents were either unemployed or had part-time employment. As a result, a high proportion of the respondents received less than R800 per month, whilst a small proportion had income above US\$350 per month. The results indicate that high percentage of the respondents lived below the poverty line.

### 4.4.2 Production of egg-laying chicken and eggs in rural Mkhambathini

#### *Production of egg-laying chickens*

The majority of households in the study area owned between one and ten chickens (Table 4.2). Thirty eight percent of households owned one to five chickens and 40% owned five to ten chickens. All respondents indicated that they reared free-range indigenous chickens and none of the households owned commercial layer chickens.

**Table 4.2: Ownership of chickens by rural households in Mkhambathini**

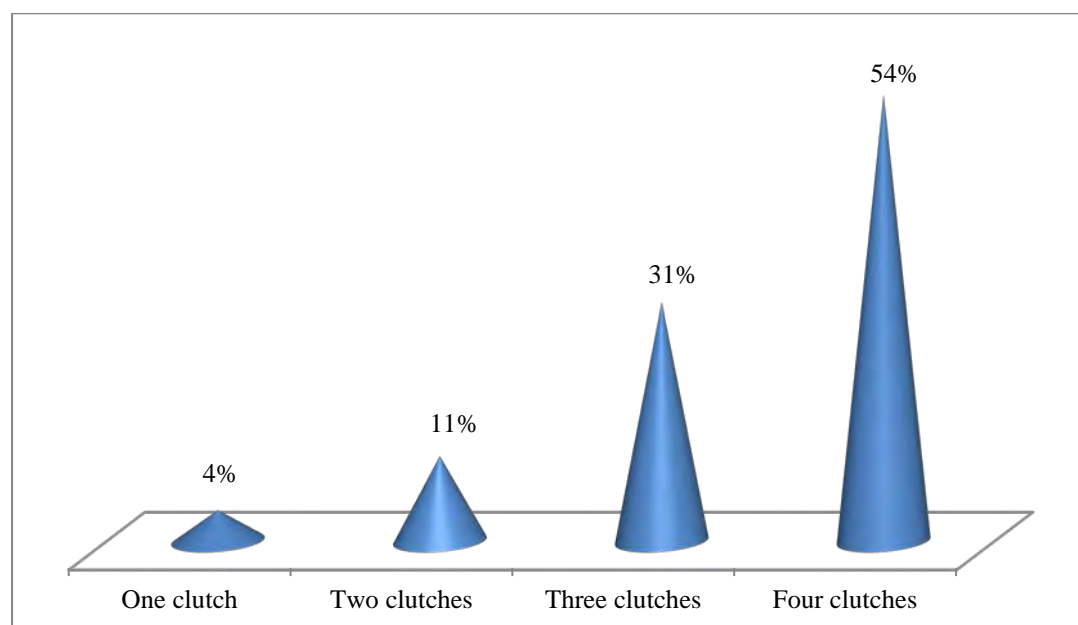
Variable	Frequency (N=110)	Percentage (%)
Less than 5 chickens	42	38
From 5-10 chickens	44	40
Greater than 10 but fewer than 50 chickens	24	22

The findings show that rural households in Mkhambathini were engaged in extensive production of free-range indigenous chickens; the flock size was generally not greater than 50. This is in agreement with the fact that low input indigenous chicken production is very popular amongst resource-poor rural communities of South Africa (Mtileni *et al.*, 2009)

Focus group discussions revealed that poultry diseases were a major challenge and for this reason a high percentage (78%) of households had fewer than eleven chickens. This hindered effective egg production. Rusirevi (2013) reported that small-scale production of village chickens by Zimbabwean households was characterised by low productivity due to diseases. The results indicate that in rural Mkhambathini, chickens are largely owned by women (68%), males only account for 21% of ownership and children 11%. This is in agreement with previous findings (Halima *et al.* 2007; Mapiye *et al.* 2008). Although 21% and 11% of the men and children, respectively, owned chickens, only 16% and 7% of the men and children, respectively, were responsible for chicken management in their households. This leaves women predominantly responsible for chicken management. The literature revealed that housing, feeding and general management of village chickens are seen as the responsibility of women (Dinka *et al.* 2010). A study conducted by Leta and Bekana (2010) in Ethiopia demonstrated that 92.4% of women were responsible for chicken management. In another study, Mapiye *et al.* (2008) concluded that 95% of rural women were responsible for chicken rearing.

### *Production of eggs*

A high proportion of the respondents indicated that in a year, a hen lays a maximum of four clutches of eggs while a very low proportion of the respondents indicated that only one clutch of eggs is produced by one hen throughout the year (Figure 4.1).

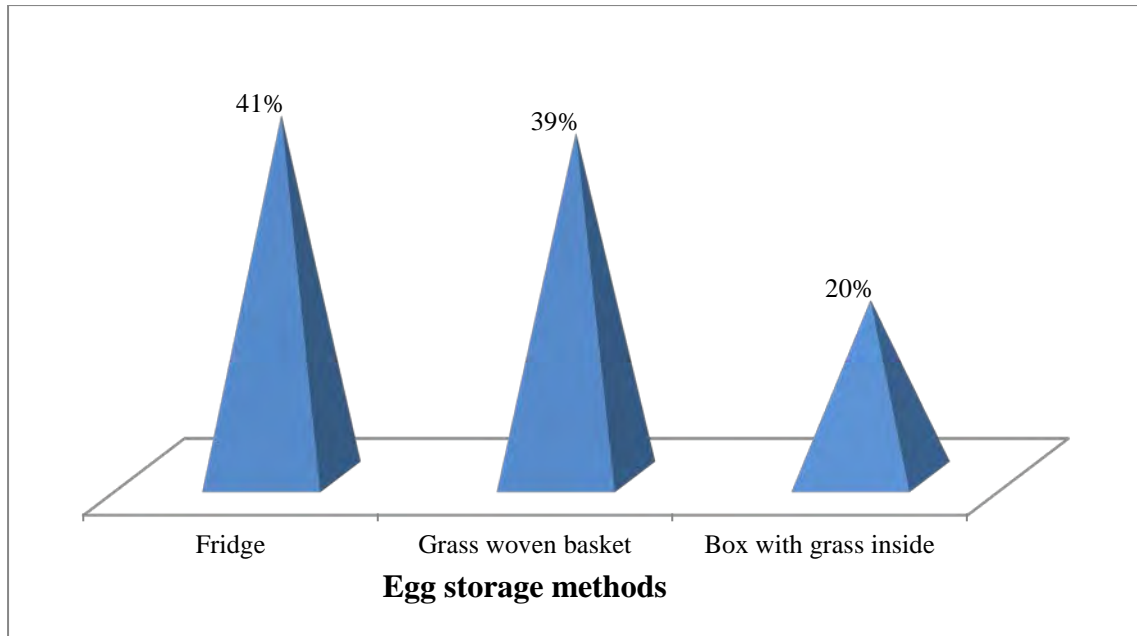


**Figure 4.1: Estimate clutching frequency per hen in a year**

In rural Mkhambathini the majority of households indicated that the clutching frequency of 4 clutches per hen in a year was observed in their flock. Similarly, Yemane *et al.* (2013) reported that the majority of respondents in Southern Ethiopia indicated that they observed a clutching frequency of 4 clutches per hen in a year while Hagan *et al.* (2013) reported that a majority of households in Ghana observed a clutch number of 3 clutches per hen in a year. The capability of a flock to effectively produce eggs or to reach the maximum clutching frequency of 4 clutches per hen in a year is strongly influenced by general flock management (Moges *et al.* 2010). In rural Mkhambathini egg production was characterised by low input and output system and scavenging was a major feeding system. This justifies the reason why 46% of the respondents never observed the maximum clutching frequency of 4 clutches of eggs per hen in a year. Although eggs may be produced in rural Mkhambathini, focus group discussions revealed that chickens were lost through diseases and predation. Among the classes of chickens, chicks and hens were severely attacked by predators. The findings indicate that there is a need for training rural households of Mkhambathini on general flock management; this will contribute to the effective production of eggs in the study area.

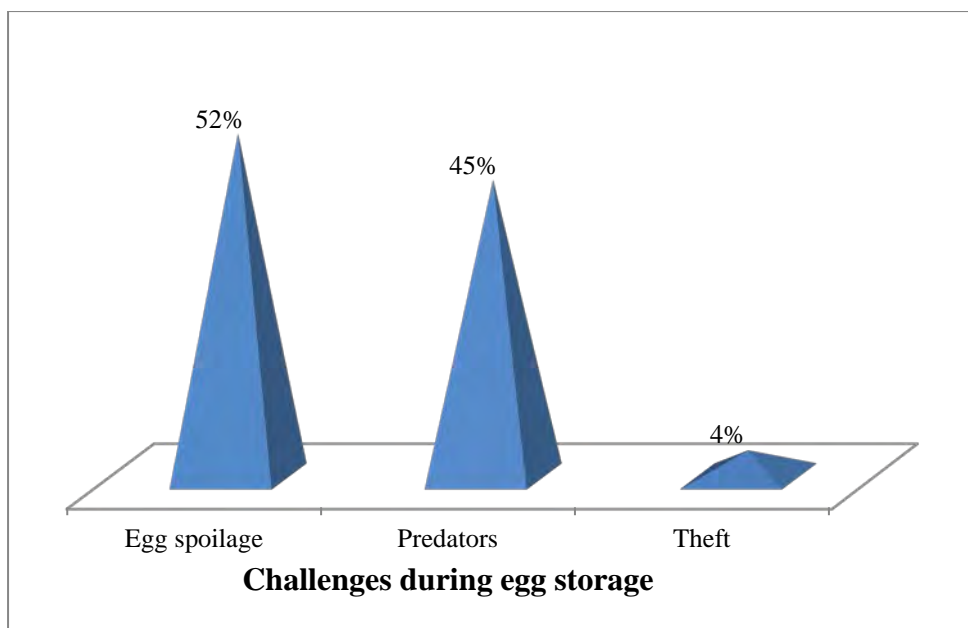
### *Egg storage systems*

A high proportion of households had poor egg storage methods and only a few households had access to modern preservation technologies in rural Mkhambathini (Figure 4.2).



**Figure 4.2: Egg storage methods in rural Mkhambathini**

The findings showed that egg storage was a major challenge for rural households in Mkhambathini. Only 41% of the households had access to modern preservation technologies such as refrigerators, 39% of the households stored eggs in grass woven baskets and 20% stored them in boxes with the inside covered with grass. Similar egg storage challenges have been reported in rural areas of other African countries. Molla (2010) found that about 57.1% of rural households in Ethiopia stored eggs on nests, 18.5% in baskets and 5.6% in iron dishes. Due to poor egg storage methods, eggs do not last long in storage in rural Mkhambathini. Up to 84% of the respondents in this study reported that eggs did not maintain their quality after more than two weeks of storage. Figure 4.3 shows the challenges during egg storage for rural households in Mkhambathini.



**Figure 4.3: Egg storage challenges for rural households in Mkhambathini**

Egg spoilage was reported to be a major problem followed by predators such as dogs, cats and snakes. Theft was applicable to only 4% of the respondents. This suggests that rural households in Mkhambathini require an egg preservation technique to increase the shelf life of eggs.

#### 4.4.3 The importance of chickens in rural Mkhambathini

Table 4.3 shows that rural households in Mkhambathini utilised chickens, including egg layers, in several ways. Quite a high proportion (36%) of the households utilised chickens for traditional purposes only and for consumption and sale (23%). A low proportion of the households utilised chickens for sale only (6%) and for both consumption and traditional purposes (3%).

**Table 4.3: Utilisation options with chickens**

Variable	Frequency (N=110)	Percentage (%)
Egg production and meat consumption	21	19
Traditional purposes	40	36
Sale only	7	6
Consumption and sale	25	23
Consumption and traditional purposes	3	3
Consumption, sale and traditional purposes	14	13

These results show that rural households in Mkhambathini utilise chickens to meet their socio-economic needs. These findings are in agreement with previous reports that indicated that rural households utilise chickens for several socio-economic purposes, including egg and meat consumption, generating income and performing traditional ceremonies (Aklilu *et al.* 2008; Dinka *et al.* 2010). The traditional use of chickens includes their use during ceremonies to appease ancestors. Eggs are valued differently by rural households of Mkhambathini; Table 4.4 summaries the most important findings from focus group discussions.

**Table 4.4: The value of eggs to rural households in Mkhambathini**

Question	Theme	Concept	Quotes	Discussion
<b>What is the importance of eggs?</b>	Socio-cultural aspect	Traditional benefits	<i>“we do not eat our eggs, we leave them to hatch because we need more chickens to perform traditional ceremonies such as appeasing the ancestors”</i>	Eggs are part of household diets because they are considered to be nutritious. They are also used as a coping strategy during periods of stress, whereby households rely on eggs as an alternative
	Socio-economic aspect	Economic benefit	<i>“we do not eat village chicken eggs because we want to have more chickens so that we can sell them to those who want to perform traditional ceremonies”</i> <i>“when we have enough chickens and eggs, we sell them to the locals”</i>	relish. Eggs are also valued for increasing the flock size in order to perform ceremonies and as a way of generating income.
	Source of food	Coping strategy	<i>“we eat eggs when we do not have enough money to purchase meat products therefore eggs serve as an alternative Isishebo”</i>	
		Nutritional benefits	<i>“we eat eggs because they are very important for our health”</i>	

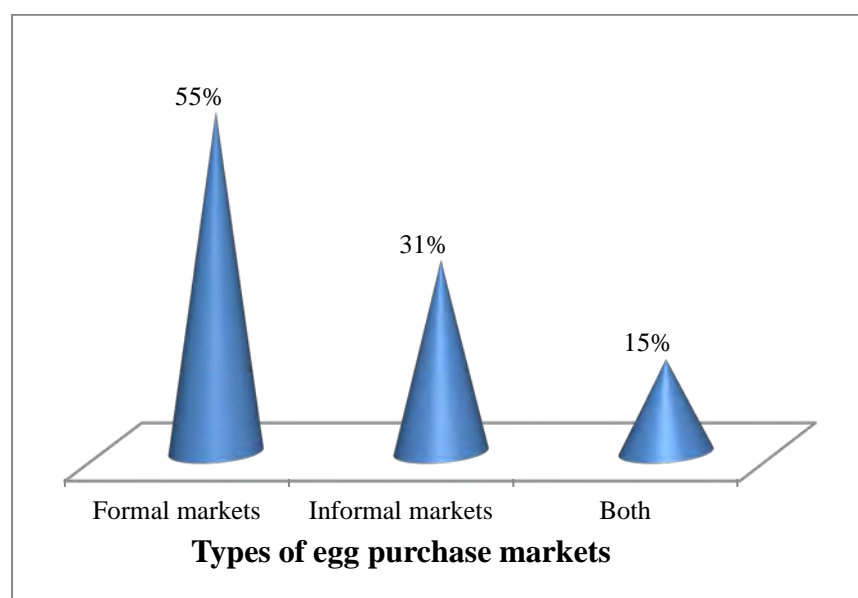
Focus group discussions revealed that there was no form of egg marketing operation in rural Mkhambathini. The only informal marketing operation in the area was the selling of live village chickens, which has already been discussed. These findings are different to what was reported by Moges *et al.* (2010). The latter reported that 69.3% of rural households in North-West Ethiopia sold their eggs in urban markets, local markets and farm gates whereby urban

market was the first priority for 70% of rural producers followed by nearest local market and farm gate sales. The findings by Moges *et al.* (2010) indicate that eggs are a marketable commodity. Households in rural Mkhambathini need to be trained on this aspect to establish an egg marketing operation in the area.

In rural Mkhambathini, eggs were mostly kept for increasing the flock size and household consumption during periods of stress. In contrast, other rural households have been found to keep eggs mainly for chicken breeding (Moges *et al.* 2010; Alders & Pym 2009). Focus group discussions confirmed that households consider eggs as a nutritious food product which is included in household diets consisting of several egg-based dishes, including their use as an alternative relish when households do not have enough money to purchase meat products. Similarly, a study conducted by Moges *et al.* (2010) revealed that rural households produced eggs to increase the chicken flock size and the remainder of the eggs were largely consumed at household level.

#### **4.4.4 Markets from which eggs are purchased by households in rural Mkhambathini**

All the respondents indicated that they purchased eggs from the markets, even though they reared egg-laying chickens. Figure 4.4 indicates the proportion of respondents who purchased eggs from formal markets and informal markets.



**Figure 4.4: Egg purchase markets for rural households in Mkhambathini**

About 55% of the households purchased eggs from formal markets, 31% from informal markets and 15% from both market types. It was established from the focus group

discussions that eggs from formal markets were considered clean, safe for consumption and well-packaged. However, eggs from informal markets were considered small in size, dirty and watery. Respondents revealed that they purchased eggs from informal markets during periods of financial stress, as they were cheaper compared to eggs from formal markets. Focus group discussions revealed other important findings linked to the reasons why households purchase eggs, despite the fact that they reared egg-laying chickens.

**Table 4.5: Reasons why the majority of households in rural Mkhambathini acquired eggs from the markets rather than consuming the eggs produced by chickens they reared**

Question	Theme	concept	Quote	Discussion
<b>Why purchase eggs yet you have egg-laying chickens</b>	Preferences	Food choice	<i>“village chicken eggs have a bad smell hence we prefer eggs from the shop” “although we know that there are no chemicals used in village chickens and that the strong colour of the egg makes food look good, but we are just not used to consuming it”</i>	Households tend to prefer the type of food products they are used to. Beliefs restrict the brides from consuming eggs produced at household level. Households leave chickens to hatch because they want to give their relatives chickens.
	Socio-cultural aspect	Ubuntu	<i>“we buy eggs because we want more chickens from our eggs, we have to give our brides and relatives chickens when they visit”</i>	
	Beliefs	Tradition	<i>“when you are married, you do not eat eggs from home, that is why we purchase eggs”</i>	

Only 27% of the households surveyed preferred village chicken eggs, because they perceived them as not having any “added chemicals”, whilst 66% of the respondents preferred commercial fresh eggs because they perceived them to be safe for consumption and were accustomed to using them for food. About 6% of the households used either commercial or village chicken eggs, depending on their financial situation.

Focus group discussions revealed that respondents were influenced by various factors when purchasing eggs. Price, expiry date and size of the eggs were regarded as the major determinants for the decision to purchase eggs or not. Brand names were regarded as the least important aspect by the respondents because: “the name does not guarantee fresh eggs”. In a month, only 12% of the households purchased more than 60 eggs and only 21% of the



households spent more than R60 on buying eggs. The average household size of the sampled households was eight individuals. It seems that the households studied were not purchasing enough eggs to meet household consumption demand. This could be partly attributed to the fact that the households had several market access challenges, which are summarized in Table 4.6

**Table 4.6: Egg market access challenges experienced by households in rural Mkhambathini**

Question	Theme	Concept	Quotes	Discussion
<b>Market access challenges</b>	Egg sales	Market standards	<i>"our eggs are too small in size and too few to be accepted in markets"</i>	Although households are informed about market standards, they are not quite informed about market information in relation to market demand for village chicken eggs. Lack of infrastructure and economic power restricts households from accessing markets.
		Market information	<i>"I doubt they even accept village chicken eggs"</i>	
	Egg purchases	Infrastructure and financial power	<i>"shops are very far and taxis are very expensive, even if you get home and find that your eggs are rotten, you cannot afford to take them back"</i> <i>"even if our eggs were big enough in size and too many to meet market demand, we don't have a car to transport the eggs"</i> <i>"when you are in a taxi you have to hold your eggs very tight to avoid breakage"</i> <i>"eggs are very expensive"</i>	

The households of the study area are located far from markets, which significantly limits their access to markets. This is in agreement with observations of Thamaga-Chitja and Morojele (2014), who stated that rural households in South Africa were faced with the geographical burden of being located in remote areas, where the roads are poorly developed. The long distance between rural household homes and markets increases the risk of egg breakage. Transport costs are also a factor. Rusirevi (2013) found that rural egg producers in Zimbabwe lacked appropriate infrastructure for transporting their eggs to the markets and transport costs were very high.

#### 4.4.5 Importance of eggs in the diets of rural households of Mkhambathini

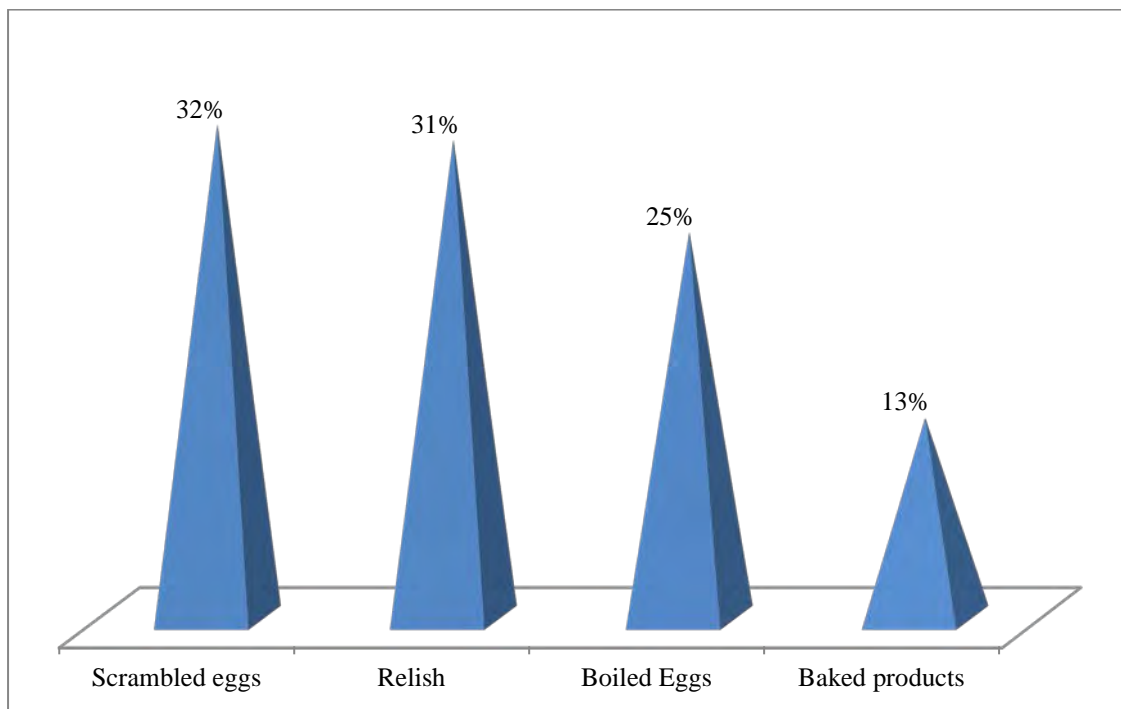
About 79% of the sampled households regarded eggs as an important food source to be included in the household diet. In rural Mkhambathini, eggs appeared to be the frequently consumed source of protein; about 34% of the households consumed eggs more than five times a week. None of the households consumed red meat more than five times a week and 25% of the households did not consume red meat at all, because it was considered very expensive. Only 4% of households consumed beans more than five times a week because they were regarded as very hard to cook. Focus group discussions revealed that, other than nutritional benefits, there were other reasons why households included eggs in their diet (Table 4.7).

**Table 4.7: Reasons why households in rural Mkhambathini included eggs in their diets**

Question	Theme	Concept	Quotes	Discussion
<b>Importance of eggs in household diet</b>	Food preparation	Convenience	<i>“eggs are very easy to prepare”</i>	Other than nutritional benefits, eggs were mainly preferred for their convenience and flavour.
			<i>“when our kids come back from school, we don’t have to cook a full meal, we just give them eggs and bread”</i>	
		Flavour	<i>“They are very tasty, our kids love them”</i>	

Eggs were perceived by households as a tasty, convenient food, which did not require too many ingredients to prepare into a dish. However, there are various circumstances which hinder egg consumption in rural Mkhambathini. Egg consumption is restricted by various circumstances across age groups and gender. When girls and boys approach puberty, they are forced to stop consuming eggs, as it is believed that eggs increase their sexual drive. Newly-wed brides are also not allowed to consume eggs until they are given permission to do so. However, in one part of one of the three sampled villages, households reported that they no longer held such beliefs, since they were more informed about the nutritional benefits of eggs in the household diet.

The respondents indicated that eggs were used to prepare several dishes. The main dishes reported were scrambled eggs, relish, boiled eggs and baked products. Amongst these dishes of egg preparation, scrambled eggs and relish were the leading preferences (Figure 4.5).



**Figure 4.5: Egg dishes preferred by rural households in Mkhambathini**

Scrambled eggs were mostly consumed with bread and focus group discussions revealed that scrambled eggs and bread was the leading preferred dish, because it is very easy to prepare and does not require too many ingredients. The dish is usually consumed as a breakfast and lunch. The egg-based relish is prepared using onions and tomatoes. It is mainly a dinner meal, consumed with *phuthu* (crumbly maize porridge) or rice. From the focus group discussions it was established that the egg-based relish acted as an alternative to the meat-based relish when households did not have enough money to purchase meat. Similarly, in Ghana, households prepare a meal called *Oto*, which is a mixture of yam and eggs in the form of a relish; rural households in Zambia consume eggs as relish, together with a staple maize porridge called *Nshima*; and in Kenya households prepare cabbage and eggs as a relish served with a staple maize porridge called *ugali* (Tembo 2012). In this study, baking was the least preferred method of preparing an egg dish because, according to the respondents, “it requires too many expensive ingredients”. Boiling eggs was considered not feasible for preparing an egg dish for the whole family. Similarly, in Mozambique and Tanzania eggs are rarely used in baked products by households unless there is a religious or holiday celebration (Webb & Roten 2011).

#### 4.4.7 Sensory acceptability of relish and sandwich prepared with egg powder

The sensory acceptability of relish and sandwich prepared with egg powder compared to the corresponding dishes prepared with fresh eggs (controls) are shown in Tables 4.8 and 4.9

**Table 4.8: Sensory acceptability of relish prepared with egg powder, compared to relish prepared with fresh egg (N=51)**

Sensory attribute	Rating	Relish (egg powder) n (%)	Relish (fresh egg) n (%)
Aroma	Very bad	16* (31.4)**	8 (15.7)
	Bad	7 (13.7)	7 (13.7)
	Neutral	3 (5.8)	7 (13.7)
	Good	15 (29.4)	20 (39.2)
	Very good	10 (19.6)	9 (17.6)
Taste	Very bad	0(0)	0 (0)
	Bad	3(5.9)	5 (9.8)
	Neutral	6(11.8)	7 (13.7)
	Good	27(52.9)	23 (45.1)
	Very good	15(29.4)	16 (31.4)
Colour	Very bad	6 (11.8)	2 (3.9)
	Bad	5 (9.8)	7 (13.7)
	Neutral	6 (11.8)	3 (5.9)
	Good	25 (49.0)	26 (51.0)
	Very good	9 (17.6)	13 (25.5)
Texture	Very bad	6 (11.8)	0 (0)
	Bad	4 (7.8)	4 (7.8)
	Neutral	5 (9.8)	5 (9.8)
	Good	26 (51.0)	25 (49.0)
	Very good	10 (19.6)	17 (33.3)
Overall acceptability	Very Bad	5 (9.8)	2 (3.9)
	Bad	4 (7.8)	3 (5.9)
	Neutral	5 (9.8)	5 (9.8)
	Good	20 (39.2)	21 (41.2)
	Very good	17 (33.3)	20 (39.2)

\*Number of respondents who gave the rating; \*\* % of respondents who gave the rating

A relatively high proportion (45%) of the respondents disliked the aroma of the relish prepared with egg powder. There was also a significant proportion (29.4%) of respondents who did not like the aroma of the relish prepared with fresh egg. The taste acceptability of both relish made with egg powder and fresh egg was similar and high. The colour and texture acceptability of both the relish made with egg powder and fresh egg were also similar and high, but the acceptability of the sensory attributes of the fresh egg relish was higher. The overall acceptability of both types of egg relishes was very high.

The findings show that, generally, the sensory properties of relish made with egg powder and relish made with fresh egg are similar. However, it seems that there is quite a problem with

the aroma of the relish made with egg powder, as it was less acceptable when compared with fresh egg relish. This suggests that processing of egg into powder results in chemical changes that produce unfamiliar odour substances. Nevertheless, it is important to note that the aroma did not have a negative influence on the overall acceptability of relish prepared with the egg powder. The findings suggest that egg powder can be used as a substitute for fresh eggs when preparing an egg-based relish.

**Table 4.9: Sensory acceptability of sandwich prepared with egg powder, compared to sandwich prepared with fresh egg (N=51)**

Sensory attribute	Rating	Sandwich (Egg powder) n (%)	Sandwich (Fresh egg) n (%)
Aroma	Very bad	2* (3.9)**	1 (2.0)
	Bad	4 (7.8)	5 (9.8)
	Neutral	12 (23.5)	11 (21.6)
	Good	18 (35.3)	23 (45.1)
	Very good	15 (29.4)	11 (21.6)
Taste	Very bad	2 (3.9)	2 (3.9)
	Bad	1 (2.0)	1 (2.0)
	Neutral	2 (3.9)	1 (2.0)
	Good	31 (60.8)	20 (39.2)
	Very good	15 (29.4)	27 (52.9)
Colour	Very bad	2 (3.9)	1 (2.0)
	Bad	3 (5.9)	4 (7.8)
	Neutral	2 (3.9)	2 (3.9)
	Good	29 (56.9)	26 (51.0)
	Very good	13 (25.5)	18 (35.3)
Texture	Very bad	3 (5.9)	2 (3.9)
	Bad	0 (0)	4 (7.8)
	Neutral	1 (2.0)	2 (3.9)
	Good	31 (60.8)	21 (41.2)
	Very good	16 (31.4)	22 (43.1)
Overall acceptability	Very Bad	1 (2.0)	1 (2.0)
	Bad	2 (3.9)	4 (7.8)
	Neutral	0 (0)	1 (2.0)
	Good	24 (47.1)	15 (29.5)
	Very good	24 (47.1)	30 (58.8)

\*Number of respondents who gave the rating; \*\* % of respondents who gave the rating

The aroma, taste, colour and texture acceptability of the sandwich prepared with egg powder and sandwich prepared with fresh egg were similar and high. A very low proportion of respondents disliked any of the sensory attributes of the sandwich prepared with egg powder and fresh eggs, respectively. This contributed positively to the overall acceptability of both sandwich types, which was similar and very high. The similar sensory acceptability of the two egg types suggests that egg powder can be used as a substitute for fresh eggs when preparing an egg-based sandwich.

#### **4.6 Conclusion**

The study shows that rural households in Mkhambathini keep village chickens for several socio-economic purposes, including for meat and eggs which they consume; sale and traditional ceremonies. The respondents perceived eggs as a nutritious and convenient food which should be included in household's diet. However, cultural beliefs, to some extent, restrict the consumption of eggs by some members of the household who are in different social and physiological circumstances. Respondents highlighted that they were experiencing challenges concerning egg storage, which resulted in losses due to spoilage and predation. This limited the utilisation of eggs to contribute to food and nutrition security. The results of the sensory evaluation indicated that the sensory acceptability of relish and sandwich prepared with egg powder is similar to the corresponding dishes prepared with fresh eggs. Using commercial egg powder as a model for indigenous knowledge-based egg powder processed at rural household level, the study demonstrated that egg powder has great potential for use in place of perishable fresh eggs by rural households to enhance their food and nutrition security.

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## **CHAPTER 5 : EVALUATION OF THE POTENTIAL OF ADAPTED EGG POWDER FOOD PRODUCTS TO CONTRIBUTE TO FOOD AND NUTRITION SECURITY**

### **5.1 Abstract**

In this study, two most commonly consumed local egg-based food products (relish and sandwich) were prepared with commercial egg powder and evaluated for their nutritional quality. The cost effectiveness and profitability as well as the perceived benefits of producing egg powder at a household level by rural households were evaluated. The nutritional composition of egg powder food dishes was determined using standard methods of the Association of Official Analytical Chemists (AOAC). Market research was conducted to assess the accessibility of egg powder to rural households. The cost effectiveness of producing egg powder at a household level compared to purchasing it from commercial markets was evaluated. A total of 40 household representatives participated in focus group discussions to assess the perceived benefits of producing egg powder at a household level. Generally, the nutrient content, including protein, of commercial egg powder and fresh egg was similar, except that the egg powder had higher gross energy. The findings indicate that processing eggs into powder does not adversely affect its nutritional composition. The energy content of the egg powder products was higher than that of the corresponding fresh egg products and it was vice versa for protein content. The mineral composition of the egg powder and fresh egg products was similar. Generally, the egg powder relish was nutritionally superior to the other products made with powder and fresh egg, respectively, in terms of mineral content, fibre and gross energy. Although the protein content of egg powder relish and sandwich was lower than that of the corresponding fresh egg products, it was nutritionally substantial. The results suggest that, in the form of relish and sandwich, egg powder has the potential to alleviate Protein-Energy Malnutrition. The results showed that it could be cost effective for the rural households to produce their own egg powder compared to purchasing it from commercial markets, and it would be profitable to sell egg powder compared to selling unprocessed eggs. The focus group discussions indicated that the households had positive perceptions and willingness to produce egg powder for improved food and nutritional security while at the same time generating income.

### **5.2 Introduction**

The physical and economic access to nutritious food is a major constraint for rural households in developing countries (Hendriks 2005; SSA 2011). This increases the risk of malnutrition. Malnutrition is defined as either under nutrition (underweight, wasting and

stunting) or over nutrition (overweight and obesity) (Joosten & Hulst 2008). Protein, vitamin A, zinc and iron deficiencies are a major concern among children and adults in developing countries, especially in sub-Saharan Africa. South Africa is ranked among the top 20 countries with the highest burden of undernutrition whereby approximately 1 in 10 children is underweight and 1 in 5 children is stunted (Tathiah *et al.* 2013). The prevalence of Protein-Energy Malnutrition in rural areas of South Africa is worsened by the inadequate intake of protein and energy. Eggs are composed of energy, high quality protein, vitamins and minerals (Schmier *et al.* 2009), which can contribute to the alleviation of Protein-Energy Malnutrition. Eggs have been largely criticised for increasing the risk of diseases due to the high cholesterol content (Spence *et al.* 2010; Djousse *et al.* 2010 & Barraj *et al.* 2009). However, various studies have indicated that the nutrients composed in an egg are essential nutrients which increase the resistance to diseases in the human body (Bologa *et al.* 2013; Schmier *et al.* 2009). They provide essential portions of nutrients which are required daily by the human body for growth and maintenance of body tissues (Asghar & Abbas 2012; Belitz *et al.* 2009, Njike *et al.* 2010; Shin *et al.* 2013).

There are various challenges which hinder rural households from utilising eggs as a constant source of animal protein. Egg spoilage has been reported as the most dominant challenge (Cherian 2008; Moges *et al.* 2010; Moreki *et al.* 2011). This suggests that eggs have a short shelf life and are highly perishable. Therefore, there is a need for an egg preservation technique which will enhance the utilisation of eggs as a source of protein in rural households. Rural households can use egg powder as a preservation strategy. Egg powder has been used successfully by the food industry as a convenient alternative to fresh egg (Rannou *et al.* 2013) because of its functional properties, increased shelf life, nutrient density, ease of storage and transportation (NPCS 2012; Rao & Labuza 2012). The adoption of egg powder as an egg preservation technique could therefore contribute to the food and nutrition security of rural households and also has the potential to diversify their livelihood options through entrepreneurship opportunities.

In this study, two most commonly consumed local egg-based food products (relish and sandwich) were prepared with egg powder and evaluated for their nutritional quality. The cost effectiveness of producing egg powder at a household level versus purchasing egg powder from commercial markets was evaluated, as well as the profitability of egg powder trade at rural household level.

### **5.3 Research methodology**

#### **5.3.1 Research technique**

A mixed research methodology was used to collect both quantitative and qualitative data. Quantitative data was collected using laboratory-based experimental designs and a market research determining the cost of egg powder in the commercial market. Qualitative methods, namely, focus group discussions were used to collect data on the perceptions on egg powder production at a household level.

#### **5.3.2 Sampling technique**

The criteria for including households from the three selected villages (Maqongqo, Ophokweni and Abebhuzi) in the study were that they were engaged in egg production, were consumers of egg-based food products and volunteered to participate in the study. Key informants were used to identify the households engaged in chicken rearing. From the survey participants (described in chapter 4), a purposeful quota sample of 20 adult women and 20 youths (16 to 35 years old) participated in a series of four focus group discussions (FDGs) (same focus group mentioned in chapter 4) to assess the perceived benefits of producing egg powder at a household level.

#### **5.3.3 Research procedure**

##### **Focus group discussions**

A series of four focus group discussions were conducted in the study area to determine the perceived benefits of producing egg powder at a household level by rural households of Mkhambathini. The focus group discussions were conducted following a focus group discussion guide and they were facilitated by field workers who were fluent in IsiZulu. The focus group discussion guide was first formulated in English (Appendix E) and then translated into IsiZulu (Appendix F). The participants of the focus group discussions were recruited on a voluntary basis from the survey participants. In order to obtain different perceptions from different age groups, the participants were divided into two demographic groups, youths and adult women. Each focus group discussion was made up of eight to twelve participants. A digital video camera was used to record the focus group discussion sessions. The recorded data was transcribed into text. The transcribed text, together with handwritten notes were used to generate the main findings of the focus group discussions.

### **Preparation of egg samples for nutritional analysis**

The egg powder used in this study was purchased from Sun Spray Food Ingredients, which is an egg powder manufacturing factory located in Bronkhorstspuit, South Africa. Fresh eggs bought from a supermarket in Pietermaritzburg were used as a control. The control was selected because the egg powder was produced using fresh eggs obtained from suppliers who supply supermarkets with eggs.

A method described by Ross (2008) was followed to reconstitute egg powder. According to Ross (2008), in order for egg powder to be reconstituted, one levelled tablespoonful of egg powder should be mixed with two level table spoons of water. The mixture should then be allowed to stand for five minutes to settle. The egg samples were prepared following the recipes used by the local community to prepare relish and sandwich (Appendix E and Appendix F). After the samples were prepared, they were freeze dried and analysed for nutritional composition.

### **Nutritional analysis**

Using standard methods, the egg samples were analysed for their protein, gross energy, fat, NDF (Neutral Detergent Fibre), total mineral (ash) and individual mineral contents. A brief description of how each of the nutrients was determined is given below:

#### *Protein*

The protein content was determined by the Dumas combustion method (AOAC official method 968.06) (AOAC 2002).

#### *Gross energy*

The energy content of the samples was measured following the bomb calorimetry method (LECO Corporation, St Joseph, Michigan, USA) (2003).

#### *Fat*

The fat content was analysed using soxhlet procedure following AOAC official method 920.39 (AOAC 2002)

### *NDF*

The fibre content of the samples was determined as the neutral detergent fibre (NDF). The NDF was determined following AOAC official method 2002.04 (AOAC 2002)

### *Total mineral content*

The ash was measured according to the AOAC official method 942.05 (AOAC 2003).

### *Individual minerals*

The calcium, magnesium, manganese, zinc, iron, sodium, potassium, copper and phosphorus were analysed following the AOAC Method 6.1.2 (AOAC 1984).

## **Market research**

A market research was conducted to review the cost of egg powder in the commercial market. Commercial food websites were used to search for information using key words such as “cost” or “cost benefit analysis” and “egg powder”. The cost effectiveness of egg powder in the commercial market was compared to producing egg powder at a household level for rural households in Mkhambathini.

## **4.4 Validity and reliability of methods**

Focus group discussions were conducted by a trained facilitator who was fluent in isiZulu. The nutritional analysis of the egg samples was conducted in duplicate using standard methods. To ensure quality control, various steps were taken during preparation of the samples. These included using the same sample ingredients and same measurements to prepare egg powder and fresh egg samples and samples were also clearly labeled to avoid mix-up.

## **4.5 Data analysis**

The Statistical Package for Social Sciences (IBM SPSS), version 21 was used to generate means and standard deviations which were calculated from the duplicate nutrient values. An independent samples *t*-test was used to determine whether there was a significant difference in the nutritional composition of egg samples. A *p*-value of < 0.05 was regarded as being statistically significant. Focus group discussions were analyzed by linking themes, concepts, patterns and quotes which emerged from the discussions with the relevant literature

## 5.4 Results and discussion

### 5.4.1 Evaluation of the potential contribution of adapted egg powder food products to nutrition security through nutritional analysis

The two most commonly consumed egg-based food products (relish and sandwich) were prepared with egg powder and fresh egg (the control) and analysed for nutritional composition. Table 5.1 and 5.2 shows the nutritional and mineral composition of egg powder compared to fresh egg (the control).

**Table 5.1: Nutritional composition of egg powder compared to fresh egg (on dry basis)**

	Ash <sup>c</sup> g/100g	Fat g/100g	Protein g/100g	Energy KJ/100g
Egg powder	3.66 <sup>a</sup> (0.03) <sup>b</sup>	36.72 (0.64)	50.43 (0.27)	<b>28.97</b> <b>(0.00)</b>
Fresh egg	3.68 (0.02)	34.45 (2.11)	52.03 (0.51)	<b>28.58</b> <b>(0.02)</b>

<sup>a</sup>Mean

<sup>b</sup>Standard deviation

<sup>c</sup>Total mineral content

Values in bold are significantly different (Independent samples *t*-test, *P* < 0.05)

Generally, the total mineral content (ash), fat and protein content of egg powder and fresh egg were similar. The gross energy level of egg powder was significantly higher than that of the fresh egg. The findings suggest that processing eggs into powder does not adversely affect the mineral, fat or protein content of eggs.

**Table 5.2: Mineral composition of egg powder compared to fresh egg (on dry basis)**

	Ca Mg/100g	Mg Mg/100g	K Mg/100g	Na Mg/100g	P Mg/100g	Zn Mg/100g	Cu Mg/100g	Mn Mg/100g	Fe Mg/100g
Egg powder	<b>0.22</b> <sup>a</sup> <b>(0.00)</b> <sup>b</sup>	0.05 (0.00)	0.52 (0.00)	<b>0.47</b> <b>(0.01)</b>	<b>0.78</b> <b>(0.01)</b>	50.10 (0.07)	2.51 (0.59)	<b>2.09</b> <b>(0.00)</b>	77.24 (0.11)
Fresh egg	<b>0.18</b> <b>(0.00)</b>	0.05 (0.00)	0.50 (0.00)	<b>0.52</b> <b>(0.11)</b>	<b>0.74</b> <b>(0.00)</b>	55.88 (12.88)	5.99 (2.73)	<b>2.03</b> <b>(0.00)</b>	97.54 (8.51)

<sup>a</sup>Mean

<sup>b</sup>Standard deviation

Values in bold are significantly different (Independent samples *t*-test, *P* < 0.05)

The levels of calcium, phosphorus and manganese in egg powder were significantly higher than those in fresh egg; only the sodium level in fresh egg was significantly higher than that of the egg powder. There was no significant difference in the levels of iron, copper and zinc between egg powder and fresh egg. However, Iron, copper and zinc levels were higher in the

fresh egg. The magnesium and potassium levels were similar in both egg powder and fresh egg.

The findings demonstrate that egg powder and fresh egg have approximately the same composition of iron, copper, zinc, and potassium. This indicates that egg preservation through drying is capable of retaining most of the important minerals which are essential for human nutrition and health.

#### 5.4.2 Comparative nutritional composition of egg powder and fresh egg dishes

The nutritional and mineral composition of sandwich and relish prepared with egg powder, compared to sandwich and relish prepared with fresh egg (the control) are shown in Table 5.3 and 5.4

**Table 5.3: Nutritional composition of egg powder relish and sandwich compared to fresh egg sandwich and relish (on dry basis)**

	Ash <sup>c</sup> g/100g	Fat g/100g	NDF g/100g	Protein g/100g	Energy KJ/100g
<b>Sandwich</b>					
Egg powder	<b>4.11</b> <sup>a</sup> <b>(0.02)</b> <sup>b</sup>	33.16 (8.40)	54.56 (9.80)	<b>19.29</b> <b>(0.21)</b>	<b>23.70</b> <b>(0.05)</b>
Fresh egg	<b>4.18</b> <b>(0.01)</b>	18.14 (0.23)	68.68 (1.73)	<b>22.58</b> <b>(0.20)</b>	<b>21.78</b> <b>(0.01)</b>
<b>Relish</b>					
Egg powder	<b>9.53</b> <b>(0.08)</b>	<b>44.12</b> <b>(1.25)</b>	<b>71.87</b> <b>(6.15)</b>	<b>24.11</b> <b>(0.51)</b>	<b>26.88</b> <b>(0.04)</b>
Fresh egg	<b>8.58</b> <b>(0.08)</b>	<b>39.53</b> <b>(0.61)</b>	<b>45.46</b> <b>(7.20)</b>	<b>29.10</b> <b>(0.62)</b>	<b>26.56</b> <b>(0.06)</b>

NDF= Neutral detergent fibre

<sup>a</sup>Mean

<sup>b</sup>Standard deviation

<sup>c</sup>Total mineral content

Values in bold are significantly different (Independent samples *t*-test, *P*< 0.05)

The ash and protein levels of egg powder sandwich were significantly lower than those of the fresh egg sandwich. The gross energy content of egg powder sandwich was significantly higher than that of the fresh egg sandwich. There was no significant difference between the fat and fibre levels in both egg powder and fresh egg sandwich. The fat content was higher in egg powder sandwich and the fibre content was higher in fresh egg sandwich.



The ash, fat, fibre and gross energy levels of egg powder relish were significantly higher than those of the fresh egg relish. The protein content of egg powder relish was significantly lower than that of the fresh egg relish.

Protein content was lower in the egg powder compared to the fresh egg probably due to losses during processing. Some protein could have been lost due to the Maillard reaction. The Maillard reaction is a reaction of aldehydes and amino groups of sugar and proteins (Potter & Hotchikiss 1995). The decrease in the protein level in the egg powder sandwich and relish was compensated by an increase in the levels of fat and energy in both the egg powder sandwich and relish. According to FAO (2010), fats are key nutrients that can be used in the diet because they provide twice the amount of energy provided by proteins and carbohydrates. This indicates that egg powder sandwich and relish could be used to meet the high energy needs of malnourished children.

**Table 5.4: Mineral composition of egg powder sandwich and relish compared to fresh egg sandwich and relish (on dry basis)**

	<b>Ca</b> Mg/100g	<b>Mg</b> Mg/100g	<b>K</b> Mg/100g	<b>Na</b> Mg/100g	<b>P</b> Mg/100g	<b>Zn</b> Mg/100g	<b>Cu</b> Mg/100g	<b>Mn</b> Mg/100g	<b>Fe</b> Mg/100g
<b>Sandwich</b>									
Egg powder	<b>0.12</b> <sup>a</sup> ( <b>0.00</b> ) <sup>b</sup>	0.07 (0.00)	<b>0.37</b> ( <b>0.01</b> )	0.94 (0.00)	<b>0.34</b> ( <b>0.00</b> )	<b>34.34</b> ( <b>0.03</b> )	2.24 (0.28)	<b>16.16</b> ( <b>0.01</b> )	70.71 (5.66)
Fresh egg	<b>0.13</b> ( <b>0.00</b> )	0.08 (0.00)	<b>0.41</b> ( <b>0.01</b> )	0.94 (0.01)	<b>0.39</b> ( <b>0.01</b> )	<b>40.72</b> ( <b>0.18</b> )	3.26 (0.59)	<b>18.32</b> ( <b>0.08</b> )	78.39 (1.78)
<b>Relish</b>									
Egg powder	0.10 (0.00)	<b>0.04</b> ( <b>0.00</b> )	0.77 (0.03)	<b>2.34</b> ( <b>0.02</b> )	<b>0.38</b> ( <b>0.00</b> )	<b>22.53</b> ( <b>0.04</b> )	2.97 (0.72)	4.1 (0.01)	35.84 (1.52)
Fresh egg	0.10 (0.00)	<b>0.05</b> ( <b>0.00</b> )	0.78 (0.02)	<b>2.02</b> ( <b>0.11</b> )	<b>0.42</b> ( <b>0.00</b> )	<b>24.63</b> ( <b>0.05</b> )	2.26 (0.29)	4.1 (0.07)	45.16 (2.98)

<sup>a</sup>Mean

<sup>b</sup>Standard deviation

Values in bold are significantly different (Independent samples *t*-test,  $P < 0.05$ )

The calcium, potassium, phosphorus, zinc and manganese levels of egg powder sandwich were significantly lower compared to their levels in the fresh egg sandwich. There was no significant difference in the levels of magnesium, sodium, copper and iron in both egg powder and fresh egg sandwich. However, the magnesium, copper and iron levels were higher in fresh egg sandwich and only the sodium level was higher in egg powder sandwich.

Generally, the calcium, potassium, copper and manganese levels of egg powder and fresh egg relish were similar. The sodium level of egg powder relish was significantly higher than that

of the fresh egg relish. The magnesium, phosphorus and zinc levels of egg powder relish were significantly lower compared to those of the fresh egg relish.

The findings show that the magnesium, sodium, copper and iron levels of egg powder sandwich and the calcium, potassium, copper and manganese levels of egg powder relish were not adversely affected when preparing the egg food products.

#### 5.4.3 Comparative nutritional composition of egg powder relish and sandwich

The nutritional and mineral composition of egg powder sandwich and relish are shown in Tables 5.5 and 5.6

**Table 5.5: Nutritional composition of egg powder sandwich compared to egg powder relish**

	Ash <sup>c</sup> g/100g	Fat g/100g	NDF g/100g	Protein g/100g	Energy MJ/Kg
Sandwich	<b>4.07<sup>a</sup></b> <b>(0.08)<sup>b</sup></b>	<b>27.23</b> <b>(0.02)</b>	<b>54.56</b> <b>(9.79)</b>	19.29 (0.21)	<b>23.74</b> <b>(0.05)</b>
Relish	<b>9.52</b> <b>(0.77)</b>	<b>44.12</b> <b>(1.24)</b>	<b>71.87</b> <b>(6.16)</b>	24.11 (0.51)	<b>26.56</b> <b>(0.06)</b>

NDF= Neutral detergent fibre

<sup>a</sup>Mean

<sup>b</sup>Standard deviation

<sup>c</sup>Total mineral content

Values in bold are significantly different (Independent samples *t*-test, *P*< 0.05)

The ash, fat, NDF and energy contents of egg powder relish were significantly higher than those of the egg powder sandwich. There was no significant difference in the mean protein level of egg powder relish and egg powder sandwich.

The findings indicate that egg powder relish has a potential to contribute to Protein-Energy Malnutrition alleviation. However, the significantly high fibre content in egg powder relish compared to egg powder could be both a nutritional advantage and disadvantage- fibre is needed for the health of the gut and other physiological functions and yet the fibre could also reduce the bioavailability of other nutrients by interacting with them (WHO 2007).

**Table 5.6: Comparative mineral composition of egg powder sandwich compared to egg powder relish (on dry basis)**

	<b>Ca</b> Mg/100g	<b>Mg</b> Mg/100g	<b>K</b> Mg/100g	<b>Na</b> Mg/100g	<b>P</b> Mg/100g	<b>Zn</b> Mg/100g	<b>Cu</b> Mg/100g	<b>Mn</b> Mg/100g	<b>Fe</b> Mg/100g
Sandwich	<b>0.12<sup>a</sup></b> <b>(0.00)<sup>b</sup></b>	<b>0.07</b> <b>(0.00)</b>	<b>0.36</b> <b>(0.00)</b>	<b>0.94</b> <b>(0.02)</b>	<b>0.34</b> <b>(0.00)</b>	<b>34.34</b> <b>(0.02)</b>	2.42 (0.28)	<b>16.16</b> <b>(0.01)</b>	70.71 (5.67)
Relish	<b>0.10</b> <b>(0.00)</b>	<b>0.42</b> <b>(0.00)</b>	<b>0.77</b> <b>(0.27)</b>	<b>2.33</b> <b>(0.24)</b>	<b>0.38</b> <b>(0.00)</b>	<b>22.53</b> <b>(0.04)</b>	2.97 (0.72)	<b>4.09</b> <b>(0.08)</b>	35.84 (1.52)

<sup>a</sup>Mean

<sup>b</sup>Standard deviation

Values in bold are significantly different (Independent samples *t*-test,  $P < 0.05$ )

The magnesium, potassium, sodium and phosphorus levels of the egg powder relish were significantly higher than those of egg powder sandwich. The calcium, zinc and manganese levels of egg powder sandwich were significantly higher than those of the egg powder relish. There was no significant difference in the levels of copper and zinc between egg powder relish and egg powder sandwich

The findings show that egg powder relish is nutritionally superior compared to egg powder sandwich in terms of fat, protein, energy, fibre, magnesium, potassium, sodium and phosphorus content. This suggests that egg powder relish has high potential to improve the nutritional status of individuals who are at risk of Protein-Energy Malnutrition i

#### **5.4.4. Assessing the potential of egg powder production in rural households of Mkhambathini**

##### **5.4.4.1 Availability of eggs**

As discussed in chapter 4, rural households in Mkhambathini are actively involved in egg production whereby the majority of households in the study area owned one to five chickens (38%) and five to ten chickens (40%). About 54% of the households indicated that in a year, a hen lays a maximum of four clutches of eggs. Ahlers (2009) indicated that an average of 10-12 eggs can be laid per clutch and according to Sun Spray food ingredients, 40 medium eggs can be processed into 500g of egg powder. Therefore, assuming that a household in rural Mkhambathini has five egg-laying chickens and they all produce clutches of eggs at the same time with 10 eggs per clutch; the household could be able to produce a 500g (40 eggs) of egg powder. Table 5.7 shows estimated egg powder production assuming that hens lay clutches of eggs at the same time.

**Table 5.7: Estimated potential production of egg powder**

No. of hens	No. of eggs per clutch	No. of eggs produced	Quantity of egg powder produced
5	10	50	500 g
10	10	100	1kg
15	10	150	1.5kg

**5.4.4.2 Cost effectiveness analysis of egg powder**

The different pricing of egg powder by different suppliers is shown in Table 5.8

**Table 5.8: The pricing of egg powder by different suppliers**

Supplier	Place	Size (g/kg)	Cost (ZAR/US\$)	Target market
Sun spray food ingredients	South Africa	500g/ 0.5kg	R58.50/\$5.15	Restaurants, hospitals , boarding schools & online shoppers ( <a href="http://www.sunspray.co.za/products-egg.htm">http://www.sunspray.co.za/products-egg.htm</a> )
Honeyville farms	USA	1020g/ 1kg	R218.98/\$19.29	Online shoppers & Urban dwellers ( <a href="http://shop.honeyville.com/powdered-whole-eggs.html">http://shop.honeyville.com/powdered-whole-eggs.html</a> )
Emergency essentials	USA	1133.98g/1.13kg	R249.18/\$21.95	Online shoppers & urban dwellers ( <a href="http://beprepared.com/provident-pantry-dehydrated-whole-egg-powder-40-oz.html">http://beprepared.com/provident-pantry-dehydrated-whole-egg-powder-40-oz.html</a> )
Augason farms	San Francisco Peninsula	935g/ 0.935kg	R238.16/\$20.98	Online shoppers & urban dwellers ( <a href="http://www.walmart.com/ip/Augason-farms-Emergency-Food-Whole-Eggs-Dried-egg-product-33-0z/21777161">http://www.walmart.com/ip/Augason-farms-Emergency-Food-Whole-Eggs-Dried-egg-product-33-0z/21777161</a> )

The findings show that generally egg powder is targeted to benefit urban dwellers and it seems to be expensive for poor resourced communities. For instance, in South Africa, a 500g of egg powder (40 eggs) cost R58.50. However, the same amount can purchase 60 fresh eggs from most South African supermarkets. Although fresh eggs are the cheapest in the market compared to egg powder, the benefits are very minimal. Mnyandu (2014) indicated that there is limited use of locally produced fresh eggs in rural areas of KwaZulu-Natal due to lack of storage facilities, thus, households are forced to purchase eggs from markets. However, freshness, storage facilities and transportation still compromises the quality and fragility of

eggs. This indicates that rural households in Mkhambathini could benefit more if they could produce their own egg powder using locally available eggs since egg powder suppliers are located far from rural areas of Mkhambathini. Therefore, it appears to be cost effective for rural households in Mkhambathini to produce their own egg powder at a household level.

As established in chapter 4, eggs were the most consumed source of animal protein. About 34% of the households consumed eggs more than five times a week. The average household size in rural Mkhambathini was 8 individuals per households. In a month 12% of the households purchased 60 eggs at R65 and 79% of the households bought 30 eggs at R32 from formal markets. This could be attributed to the fact that eggs were regarded as expensive by rural households of Mkhambathini. This suggests that rural households in Mkhambathini are in need of a cost effective intervention which will enhance the consumption of eggs as a source of protein. Households in the study area could produce egg powder using locally available resources at zero cost (Table 5.9).

**Table 5.9: A summary of resources available to households in rural Mkhambathini**

Item	Description
Egg-laying chickens	Households in rural Mkhambathini are actively involved in extensive production of free-range indigenous chickens
Feeds and Feeding	Chickens in rural Mkhambathini scavenge for their own feed and are provided with water and kitchen left overs as supplementary feeding.
Housing	Currently there are no chicken housing structures in rural Mkhambathini. However, locally available material can be used to construct shelter for the chickens (Ahlers 2009).
Vaccines	Households mainly rely on indigenous knowledge systems to treat poultry diseases. This can be integrated with modern veterinary services to prevent poultry diseases (Ahlers 2009)
Preservation techniques	Currently there are limited skills in egg preservation in rural Mkhambathini. Sun drying method which is an indigenous method can be used to process eggs into powder, this method of preserving food has been practised in rural areas for many generations (Bechoff <i>et al.</i> 2011). It has been used successfully to dry meat, fish, vegetables, corn and fruits in most African countries.

On the other hand some of the rural households purchased eggs from informal markets at R20 for 30 eggs. The eggs from informal markets were supplied by other smallholder farmers

who were selling their locally produced eggs. However, as stated earlier, the supply of eggs from the rural chickens is limited due to production challenges and limited effective storage and preservation technologies.

Producing egg powder at a household level can only be possible provided that village chickens are fed a nutritious diet, vaccinated against diseases and provided with shelter to minimise egg-laying chicken loss through predation. The production of egg powder at a household level could contribute to the frequent consumption of egg-based food products since egg powder has capacity to ensure the availability of eggs at all time, this could particularly contribute to the alleviation of Protein-Energy Malnutrition. The cost and benefit of producing egg powder at a household level versus purchasing egg powder from commercial markets is shown in Table 5.10

**Table 5.10: The cost and benefit of producing egg powder at a household level compared to purchasing egg powder from commercial markets.**

	<b>Benefits</b>	<b>Costs</b>
<b>A. Producing egg powder at household level</b>	<b>Tangible benefit</b> -Availability of protein rich food product -Reduced transport cost <b>Intangible benefit</b> -Improved shelf-life of eggs -Livelihood opportunities -Improved food and nutrition security	<b>Tangible cost</b> Labour -Flock management -Producing egg powder
<b>B. Purchasing egg powder from commercial markets</b>	<b>Tangible benefit</b> -Availability of protein rich food product <b>Intangible benefit</b> -Improved shelf-life of eggs	<b>Tangible cost</b> -Transport cost -Egg powder cost - Food price increase <b>Intangible cost</b> -No livelihood opportunities
<b>C. Purchasing eggs from formal markets for producing egg powder at household level</b>	<b>Tangible benefit</b> -Availability of eggs to produce egg powder	<b>Tangible cost</b> -Transport cost -Cost of eggs -Egg quantity - Food price increase -Producing egg powder <b>Intangible cost</b> -Egg quality and fragility

Tangible= quantifiable

Intangible = not quantifiable

Table 5.10 shows that producing egg powder at a household level and purchasing egg powder from commercial markets both have the benefit of ensuring the availability of a protein rich

food product with increased shelf-life. However, by producing egg powder at a household level, rural households could minimise transportation cost. This could also diversify their livelihood options through entrepreneurship opportunities while ensuring food and nutrition security at a household level. However, purchasing egg powder from commercial markets will not open up any livelihood opportunities and households will be required to pay for transport cost and egg powder cost which is yet to increase due to price inflation. Although producing egg powder at a household level comes with the labour cost of flock management for effective egg production and producing egg powder, the inputs will be very minimal since rural households in Mkhambathini can utilise locally available resources.

#### **5.4.4.3 Analysis of profitability of egg powder entrepreneurship at rural household level**

The market prices of fresh unprocessed eggs and egg powder were provided in section 5.4.4.2 as follows:

(1) Price of fresh unprocessed eggs: (i) Formal market price = R32 for 30 eggs

(ii) Informal market price= R20 for 30 eggs

(2) (i) Price of 500 g of egg powder processed from 40 eggs = R58

(ii) Estimated price of egg powder processed from 30 eggs =  $(30/40)*R58$   
= R43.50

Therefore:

(3) (i) Gross profit from egg powder processed from 30 eggs obtained from formal market eggs

= (2) (ii)-(1)(i)=  $R43.50-R32.00=$  **R11.50**

(ii) Gross profit from egg powder processed from 30 obtained from informal market eggs

= (2) (ii)-(1)(ii)= $R43.50-R20.00=$  **R23.50**

From the above analysis, it can be seen that rural entrepreneurship in egg powder could be profitable. The eggs from the informal market are produced at rural household level and are much cheaper, they cost R20 for 30 eggs compared to R32 for 30 eggs from the formal market. Alternatively, the egg powder processor could obtain the eggs from own household production, which would further increase the profit. Therefore there is a potential to increase the utilisation of eggs produced at rural household level through local egg powder entrepreneurship. The households would earn cash income from either

the sale of eggs or egg powder or both. The increased utilisation of eggs and value added entrepreneurship (egg powder business) would increase demand for local eggs and thereby improving rural household livelihoods.

#### 5.4.5 The willingness to produce egg powder at a household level by rural households of Mkhambathini

None of the respondents in rural Mkhambathini were familiar or had knowledge of egg powder. However, focus group discussions revealed that respondents were willing to learn more about egg powder in relation to producing it at a household level. The production of egg powder at a household level was associated with socio-economic benefits by rural households of Mkhambathini. These findings are summarized in Table 5.11

**Table 5.11: The perceived benefits of producing egg powder at a household level by rural households of Mkhambathini**

Question	Theme	Quotes	Discussion
<b>How could you benefit from producing your own egg powder?</b>	Employment	<i>“learning how to produce egg powder could create jobs for the unemployed”</i>	Egg powder production at a household level is seen as a strategy to create job opportunities for income generation, easy physical access to a source of protein for household consumption and a way for ensuring food safety through improved egg storage and increased shelf life
		<i>“we can make and sell egg powder to get money”</i>	
	Protein source	<i>“we can consume the egg powder we make and save money because we won’t have to purchase eggs from markets”</i>	
	Quality, food safety & storage challenges	<i>“we won’t have to worry about buying rotten eggs from the market and egg spoilage during storage”</i>	

The households in rural Mkhambathini have indicated that producing egg powder at a household level could create job opportunities for the unemployed and also ensure egg safety and the availability of a protein rich food product at all times. The perceived benefits of producing egg powder at a household level by rural households of Mkhambathini highlights the opportunity to introduce egg powder as an egg preservation technique in rural Mkhambathini. There is a limited number of egg powder producers in South Africa, this indicates a market opportunity for rural households in the line of producing eggs and selling



them to potential egg powder producers or processing their own egg powder using the eggs they produce.

### **5.5 Conclusion**

The nutritional analysis of the preferred egg-based food products showed that the protein levels of egg powder sandwich and relish were significantly lower than the mean protein levels of fresh egg sandwich and relish. Although the protein content of egg powder relish and sandwich was lower than that of the corresponding fresh egg products, it was nutritionally substantial. The results suggest that, in the form of relish and sandwich, egg powder has a potential to alleviate Protein-Energy Malnutrition. Producing egg powder at a household level appears to be cost effective for rural households in Mkhambathini because this will enable households in rural Mkhambathini to enhance their food and nutrition security and also diversify their livelihood options through the use of locally available resources. Focus group discussions indicated that the households had positive perceptions and showed willingness to produce egg powder at a household level as they thought that it would have several socio-economic benefits, including, entrepreneurship opportunities, egg safety and availability.

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## **CHAPTER 6 : CONCLUSION AND RECOMMENDATIONS**

The main conclusions and recommendations of the study are discussed in this chapter. The aim of this study was to use commercial egg powder as a model to assess the potential of indigenous knowledge-processed egg powder to improve household food and nutrition security of rural households of Mkhambathini in KwaZulu-Natal province of South Africa.. The objectives of the study were: (i) To assess the utilisation of eggs in rural Mkhambathini; (ii) To determine the acceptability of food products prepared using commercial egg powder as a major ingredient by rural households in Mkhambathini compared with corresponding products made with fresh eggs; (iii) To evaluate the nutritional composition of food products prepared with commercial egg powder as a major ingredient compared with corresponding products made with fresh eggs; (iv) To determine the cost effectiveness of producing egg powder at household level compared to purchasing it from commercial markets, as well as rural entrepreneurship in egg powder.

### **6.1 Conclusions**

The results of this study showed that rural households in Mkhambathini are engaged in extensive production of free-range indigenous chickens. Although they were involved in egg production, there was no form of egg marketing operation in place. Poultry diseases and predation were identified as the major challenges which hindered the effective production of eggs in the study area. The households had very limited or no access to modern egg storage and preservation technologies. As a result, the households lost a significant proportion of the eggs through spoilage. The rural households of Mkhambathini utilised eggs for food and several socio-cultural practices. The household perceived eggs as an important nutritious food source as well as a highly valuable agricultural commodity for socio-cultural applications. Survey results indicated that eggs were used to prepare several dishes. Egg relish and sandwich topped other dishes in terms of consumption. Sensory evaluation results revealed that egg powder sandwich and relish were acceptable to rural households of Mkhambathini. This suggests that the sensory attributes of egg powder sandwich and relish did not have an effect on the overall acceptability of egg powder food products. From these findings it can be inferred that households in rural areas are likely to accept sandwich and relish prepared with indigenous knowledge processed egg powder if the indigenous knowledge based egg powder has similar properties as commercial egg powder.

Although the protein content of egg powder relish and sandwich was lower than that of the corresponding fresh egg products, it was nutritionally substantial. The results suggest that, in

the form of relish and sandwich, commercial egg powder has potential to contribute to the nutritional status of individual that have or are at risk of Protein-Energy Malnutrition. The study showed that producing egg powder at a household level appears to be cost effective for rural households in Mkhambathini because this could enable households in rural Mkhambathini to enhance their food and nutrition security and also diversify their livelihood options through the use of locally available resources. Focus group discussions indicated that the households had positive perceptions about producing egg powder at a household level as they thought that it would have several socio-economic benefits, including, entrepreneurship opportunities, egg safety and availability.

Overall, it appears that egg powder has the potential to be used in place of fresh egg. Egg powder has the potential to be used as an egg preservation strategy by rural households in Mkhambathini to enhance their food and nutrition security and also diversify their livelihood options.

## **6.2 Recommendations**

### **6.2.1 Recommendations for improvement of the study**

The following recommendations are made:

- a) This study was conducted in Mkhambathini, KwaZulu-Natal targeting only three villages. This limits inferring the study findings for other rural populations. Therefore, the sensory evaluation should be conducted using other rural areas of South Africa to assess the acceptability of egg powder.
- b) The study only assessed the nutritional quality of two recipes, further research should be conducted exploring other recipes prepared with egg powder as a major ingredient.

### **6.2.2 Implications for further research**

- a) Studies assessing the acceptability of food dishes prepared with egg powder as a major ingredient should be conducted in other provinces. The food dishes chosen should be one that is preferred by rural households in that province.
- b) Studies evaluating the safety of producing egg powder at a household level should be conducted.
- c) Mnyandu (2014) established that egg powder processed through sun and oven drying at household level developed a rancid flavor when observed over a period of 8 weeks. Therefore, research should be conducted on extending the shelf-life of egg powder produced at a household level.

### **6.2.3 Recommendations for policy makers**

- a) There is a need for training rural households in Mkhambathini on chicken production and management, egg value addition processing and entrepreneurship to enhance effective egg consumption and alternative utilisation. Findings in this study highlight agricultural entrepreneurship opportunities for rural households in the line of making and selling egg powder or food products made from egg powder. Such entrepreneurship would not only significantly improve the food and nutrition security and livelihood of rural households, but also contribute to rural economic development. In the long term, the smallholder farmers would likely graduate from just being subsistence farmers to commercial farmers and thus reduce the rate of unemployment, poverty, food and nutrition insecurity. These outcomes would contribute to the achievement of the goals of the South African National Developmental Plan and Food and Nutrition Security Policy. Thus, decision makers (Policy Makers and Socio-economic Development Practitioners) in agriculture (food security), social welfare and health (nutrition) could use information generated from this research to design poultry-based entrepreneurial projects and programmes aimed at improving the food and nutrition security and livelihoods of rural households.

## APPENDICES

### APPENDIX A: SURVEY QUESTIONNAIRE IN ENGLISH

University of KwaZulu-Natal

#### Questionnaire

All the information provided here will be treated as **STRICTLY CONFIDENTIAL**.

Name of interviewer.....

Date: .....

Area.....

#### Section A: Socio-economic demographics

##### 1. Gender

0=Male	1=Female

##### 2. Age

|\_|||\_|

##### 3. Marital Status

1=Single	2=Married	3=Divorced	4=Widowed

##### 4. Are you the household head?

1=Yes	0=No

##### 5. Total size of household\_\_\_\_\_

##### 6. Indicate the number of people per age category

0-12 months	1-12 years	13-19 years	20-35years	36- 59 years	Greater than 59

##### 7. Level of education

1=No Formal education	2=Primary	3=Secondary	4=Tertiary

##### 8. Employment status

1=Employed full time	2=Employed part time	3=Unemployed	4=Pensioner
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**9. Household income per month?**

Below R800	R801 – R1500	R1501-R3500	Above R3500

**Section B: Chicken keeping**

**10. a) Do you keep egg laying chickens in your household? If yes how many?**

1=Less than 5	2= from 5-10	3=more than 10

**b) In a year, how many clutches of eggs does one egg-laying chicken lay?**

1=one clutch	2= two clutches	3= Three clutches	4= Four clutches

**11. Type of egg laying chickens kept by household**

1=Village chicken	2= commercial Layer chicken	3=Both

**12. Why do you keep egg laying chickens?**

1= household egg consumption	2= sale	3= Both consumption and sale	4=Traditional purposes

**13. Who owns the chickens?**

1=adult female	2= adult male	3=children

**14. Who takes care of the chickens?**

1= adult female	2= adult male	3=children

### Section C: Egg storage

#### 15. How are eggs stored in the households?

1=Fridge	2 = Basket	3= we do not store eggs	4= Other (specify)

#### 16. How long do your eggs last in storage?

1= 1 week	2= 2 weeks	3=More than 3 weeks

#### 17. Challenges during storage

1= Theft	2= spoilage	3=predators	Other(specify)

### Section D: Egg consumption

#### 18. Why are eggs consumed in your household? Rank according to importance, 1=Not at all important, 2= not very important, 3= very important

Nutritional benefits	Flavour(they are tasty)	household preference

#### 19. How Important is including eggs in household's diet

1= not at all important	2= not very important	3= important	4=very important	5= I do not know

#### 20. Did you eat eggs in the past 30 days?

1=Yes	0=No

#### 21. If yes, how often in a week?

1= 0 per week	2= once a week	3=twice a week	4= three times a week	5= four times a week	6= Five times a week	7= six times a week	8= 7 times a week.

#### 22. Which egg dish was mostly prepared in the past 30days\_\_\_\_\_

**23. Which type of egg was used to prepare the dish?**

1= indigenous egg from household production	2= layer egg from household production	Purchased egg

**24. Rank the preferred type of egg by household. 1= most preferred, 2=least preferred or 3= not preferred.**

indigenous egg from household production	layer egg fom household production	Purchased egg

**25. At which meals are eggs consumed?**

1= Breakfast	2= Lunch	3= dinner	4=Varies

**26. How many eggs are used when preparing the following foods?**

Food type	No. of eggs used	No. of people prepared for
Scrambled eggs		
Baking		
Relish		
Other:		

**27. Any specific egg traditional dish you prepare in your households\_\_\_\_\_**

**28. Protein sources: How many times are these food products consumed in a week? 1= once, 2=Twice, 3=three times 4= four times, 5= five times, 6= more than five times, 7= Not consumed.**

Red meat	chicken	fish	beans	Eggs

#### **Section E: egg purchase**

**29. Do you purchase eggs in your household? If yes, where?**

1= informal markets	2= formal markets	3=both

**30. What qualities do you consider when buying eggs? Rank according to importance, 1=Not at all important, 2= not very important, 3= important, 4= very important**

Brand	size	price	sell by date

**31. In a month, how many eggs do you purchase?**

1= Less than 30 eggs	2= 30 eggs	3= 31-60 eggs	4= above 60 eggs

**32. How much do you spend on eggs per month?**

1= less than R30	2= R31-R60	3= above R60

**33. Which egg shell colour do you prefer**

1= white	2= brown	3= other

**34. Which egg yolk colour do you prefer?**

1= light yellow	2= golden yellow	3= orange	4=Other

#### **Section F: Egg powder**

**35. Have you heard about egg powder before? If yes, from?**

1= The media	2= extension officer	3= friends	4=neighbours	5=supermarkets

**36. Have you used egg powder before? If yes what for?**

---

**37. Would you like to learn about egg powder?**

1=yes	0= No

**38. Would you consume egg dishes prepared using egg powder?**

1=yes	0= No

**39. Name three egg dishes you would prepare using egg powder**

## APPENDIX B: SURVEY QUESTIONNAIRE IN ISIZULU

### Unyuvesi YaKwaZulu-Natali

#### Questionnaire

Yonke imininingwane etholakele izophathwa **NGOKUKHULU UKUCOPHELELA.**

Igama lombuzi: .....

Usuku : .....

Indawo.....

#### Isigaba A: Socio-economic demographics

##### 1 Ubulili

0=owesilisa	1=Owesifazane

##### 2 Iminyaka?

|\_|||\_|

##### 3 Isimo sokushada

1=Ngisingili	2=Ngishadile	3=ngihlukanisile	4=Umfelwa/umfelwakazi

##### 4 Ngabe uwe inhloko yakulo muzi?

1=Yebo	0=cha

##### 5 Nibangaki ekhaya uma uzibala nawe?\_\_\_\_\_

##### 6 Khombisa inombolo yabantu ngokweminyaka ngokubhala inombolo ebhokisini noma emabhokisini afanele

0-12 months	1-12 years	13-19 years	20-35years	36- 59 years	Greater than 59

##### 7 Izinga lokufunda

1=angiyanga esikoleni	2=amazingaphansi	3=Amazinga athe thuthu	4=Amazinga aphezulu

##### 8 Ezomsebenzi

1=Usebenza ngokugcwele	2=Usebenza nje	3=Awusebenzi	4=Uholo impesheni
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## 9 Malini engenayo ekhaya ngenyanga?

Ngaphansi kwa R800	R801 – R1500	R1501-R3500	Ngaphezu kwa R3500

### Isigaba B: Ukugcina izinkukhu

## 10 a) Uyazigcina yini izinkukhu ezizalela amaqanda emzini wakho? Uma uvuma zingaki?

1=Ngaphansi kwezi-5	2= Kusukakwezi-5-10	3=Ngaphezu kwe-10

### b)Ngonyaka, Inkukhu iyodwa izalela kangaki?

1=kanye	2= kabili	3=kantathu	kane

## 11 Izinhlolo zezinkukhu ezizalela amaqanda ezigciniwe emzini.

1=Izinkukhu zesintu	2= Izinkukhu Zomshini	3=Kokubili

## 12 Yinindaba ugcine lezi zinkukhu ezizalela amaqanda?

1= Ukudla amaqanda ekhaya	2= Ukudayisa	3=Ukudla nokudayisa	3=Ukwenza amasiko

## 13 Ubani umnikazi wezinkukhu?

1= Omdala wesifazane	2= Omdala wesilisa	3=Izingane

## 14 Ubani onakekela izinkukhu?

1= Omdala wesifazane	2= Omdala wesilisa	3= Izingane

### Isigaba C: Ukugcinwa kwamaqanda

**15 Agcinwa kanjan amaqanda emzini?**

1=eFrijini	2 = Kubhaskidi	3= Awagcinwa nhlobo	4= Okunye (Chaza)

**16 Ahlala isikhathi esingakanani lamaqanda egciniwe endaweni leyo?**

1= Iviki	2= Amaviki amabili	3= Ngaphezu kwamaviki amathathu

**17 Izingqinamba ngesikhathi kubekwa amaqanda**

1= Ukuntshontshwa	2= Ukonakala	3=Izilwane ezidla amaqanda	Okunye(Chaza)

**Isigaba D: Ukudliwa kwamaqanda**

**18 Adliwelani amaqanda kulomuzi walayikhaya? Linganisa uqale ngokubalulekile,**

**1=Okungabalulekile nhlobo, 2= Okungabalulekile, 3= Okubaluleke kakhulu**

Umsoco	Isinongo (ayanambitheka)	Okuthandwa ekhaya

**19 Kubaluleke kangakanani ukufaka amaqanda ekudleni kwasekhaya?**

1= Okungabalulekile nhlobo	2= Okungabalulekile	3= Okubalulekile	4=Okubaluleke kakhulu	5= Angaz

**20 Uke wawadla amaqanda ezinsukwini ezingama-30?**

1=Yebo	0=Cha

**21 Uma uvuma, uwadla kangaki ngesonto/ ngeviki?**

1= 0 ngesonto	2= Kanye ngesonto	3=kabili ngesonto	4= kathathu ngesonto	5= kane ngesonto	6= kahlanu ngesonto	7= kasithupha ngesonto	8= kasikhombisa ngesonto
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**22 Isiphi isidlo samaqanda esidliwe kakhulu kulezi zinsuku ezingama-30?\_\_\_\_\_**

**23 Iyiphi inhlobo yeqanda eyayisetshenzi ukulungiselela leso sidlo?**

1= iqanda eliqhamuka kumkhiqizo wasekhaya wezinkukhu zesintu	2=Iqanda eliqhamuka kumkhiqizo wasekhaya wezinkukhu zemshini	Iqanda Elithengiwe

**24 Linganisa uqale ngenhlobo yeqanda olithandayo. 1= Ngilithanda kakhulu, 2=Ngilithanda kancane or 3= Angilithandi**

iqanda lemvelo eliqhamuka kumkhiqizo wasekhaya	Iqanda eliqhamuka kumkhiqizo wasekhaya wezinkukhu zemshini	Iqanda Elithengiwe

**25 Ikusiphi isidlo lapho amaqanda edliwa khona?**

1= iBhulakufesi	2= Emini	3= Ebusuku	4=Kuyashiyana

**26 Mangaki amaqanda asetshenziswayo uma kulungiselelwa lokudla okulandelayo?**

Inhlobo yokudla	Inani lamaqanda	Inani labantu elilungiselwela bona
Amaqanda afriyiwe		
Ukubhaka		
Sishebo		
Okunye:		

**27 Isidlo semaqanda ebekade siphekwa ngekhathi zakudala esisaphekwa namanje ekhaya\_\_\_\_\_**

**28 Ukutholakala kwesakhamzimba se protheni: Kudliwa kangaki ngesonto/evikini lokudla okulandelayo? 1= Kanye, 2=Kabili, 3=Kathathu 4= kane, 5= Kahlanu, 6= Ngaphezu kwesihlanu, 7= Akudliwa.**



Inyama ebovu	Inyama yenkukhu	ufishi	Ubhotjisi	Amaqanda

**Isigaba E: Ukuthengwa kwamaqanda**

**29 Uyawathenga amaqanda emzini wakho? Uma uvuma, uwathenga kephi?**

1= emakethe engaqondile	2= emakethe eqondile	3=kokubili

**30 Iziphi izimo osibhekayo uma uthenga amaqanda? Kelisa uqale ngokubalulekile,**

**1=Okungabalulekile nhlobo, 2= Okungabalulekile, 3= Okubalulekile, 4= Okubaluleke kakhulu**

Uphawu	usayizi	inani	Usuku lokudayiswa

**31 Ngenyanga, uthenga amaqanda amangaki?**

1= Angaphansi kwama-30	2= Awu-30	3= 31-60 wamaqanda	4= Ngaphezu kuka-60

**32 Usebenzisa imali engakakanani ngenyanga ukuthenga amaqanda?**

1= Ngaphansi kuka-R30	2= R31-R60	3=Ngaphezu kuka-R60

**33 Elinjani umbala iqanda olikhethayo?**

1= elimhlophe	2= elinsundu	3= okunye

**34 Isiphi isikhupha osithandayo?**

1= light yellow	2= golden yellow	3= orange	4=Okunye

## Isigaba F: Uphawuda weqanda

**35 Useke wenza ngeqanda eliwuphawuda ngaphambilini? Uma uvuma, wezwa kephi?**

1= Kumabonakude	2=Kumeluleki wezolimo	3= kubangani	4= komakhelwane	5= emasuphamakethe

**36 Useke wawusebenzisa uphawuda weqanda ngaphambilini, Uma uvuma, kephi?**\_\_\_\_\_

**37 Uyafuna ukufunda ukusebenzisa iqanda eliwuphawuda?**

<b>1= Yebo</b>	<b>0= Cha</b>

**38 Ungadla isidlo esilungiswe ngeqanda eliwuphawuda?**

<b>1= Yebo</b>	<b>0= Cha</b>

**39 Bala izidlo zamaqanda ongazilungiselela usebenzisa iqanda eliwuphawuda?**

**a.**

**b**

**c.**



## **APPENDIX C: FOCUS GROUP DISCUSSION GUIDE IN ENGLISH**

### **A. The value and importance of eggs**

In your households you have egg laying chicken, explain why?

- Explore the value and importance of egg laying chickens
- The challenges with egg production

### **B. Egg acquirement**

Where do you get your eggs from?

- Challenges with acquirement
- Advantages

### **C. Egg Consumption and Utilisation**

In your household who consumes eggs and why?

- How many eggs are generally consumed per week and by whom?
- What types of foods are made with eggs?
- How are they prepared and quantities and for how many people?
- Are there special foods made with indigenous eggs?
- Are eggs consumed in a specific meal times?

Decision influencing the purchasing of eggs

- What informs their decisions when buying eggs?
- What are the key determinants that guide their egg purchases

### **D. Willingness to consume egg powder**

Would you be eager to consume egg powder and egg dishes made from it?

- What are the concerns?
- Why are they willing?
- What dishes could be made with egg powder and why those specific dishes?

### **E. Willingness to make egg powder**

What are the perceived reasons for this willingness?

### **F. Willingness to purchase egg powder**

Why do they think they would buy it?

- Perceived advantages or disadvantages over fresh eggs?
- How much would they pay for it and why?

## **APPENDIX D: FOCUS GROUP DISCUSSION GUIDE IN ISIZULU**

### **Isigaba A Ukubaluleka kwamaqanda**

Emzini wakho unazo izinkukhu ezizalela amaqanda, chaza isizathu salokho?

- Chaza ukubaluleka kwezinkukhu ezizalela amaqanda
- Izinqinamba ngokukhiqizwa kwamaqanda

### **Isigaba B Ukutholwa kwamaqanda**

Uwathola kephi amaqanda akho?

- Izinqinamba ngokutholwa kwamaqanda
- Okuhle ngendlela owathola ngayo

### **Isigaba C Ukudliwa Kwamaqanda**

- Ekhaya ngabe ubani odla amaqanda, ngobani?
- Ngokujwayelekile mangaki amaqanda adliwayo ngesonto, edliwa ubani?
- Iluphi uhlobo lokudla olwenziwayo ngamaqanda?
- Aphekwa kanjani kanti futhi nenani elisetshenziswa kube kwenzelwa abantu abangaki?
- Kukhona yini ukudla thizeni okuphekwa ngamaqanda ezinkukhu zesintu?
- Ngabe amaqanda adliwa ngezidlo ezithile zokudla?

Izinqumo

- Yini ekwenza uthenge amaqanda?
- Izinto ozibhekayo uma uthenga amaqanda?

### **Isigaba D. Ukudliwa kweqanda eliwuphawuda**

Isingeniso: Khombisa abantu iqanda eliwuphawuda

Ungathanda ukudla isidlo esenziwe ngeqanda eliwuphawuda, ngobani?

- Ingabe kukhona yini ukukhathazeka ngokudliwa kwaleliqanda eliwuphawuda?
- Iziphi izidlo ongazilungisa usebenzisa iqanda eliwuphawuda, yingobani ungenza lezo zidlo?

### **Isigaba E. Ukuthengwa kweqanda eliwuphawuda**

- Yin indaba becabanga ukuthi bangawathenga lamaqanda awuphawuda?
- Ubona ukuthi ikuphi okuhle nokubi ngeqanda eliwuphawuda uma uliqhathanisa neqanda elijwayelekile?
- Bangakhokha malini ukuthenga iqanda eliwuphawuda, ngobani?

### **Isigaba F. Ukwenza iqanda eliwuphawuda**

Ingabe ungathanda yini ukufunda ukuzenzela iqanda eliwuphawuda, ngobani?





## **APPENDIX E: EGG POWDER AND FRESH EGG RELISH RECIPE**

### **Egg powder relish recipe (to be consumed by four people)**

#### Ingredients

- 2 levelled table spoons of egg powder
- 4 table spoons of water
- Cooking oil
- 1 onion
- 4 tomatoes
- Stock cubes (beef/chicken depending on preference)
- Soup (beef/chicken depending on preference)
- Salt for flavour

#### Method

1. To reconstitute egg powder add 2 levelled table spoons of egg powder and 4 table spoons of water in a bowl
2. Combine the egg powder and water until smooth.
3. Heat cooking oil in a pot and add chopped onions
4. Pour the reconstituted egg powder ,stir until well combined
5. Add tomatoes and stock cubes and leave to boil until tomatoes are well done
6. Add soup powder and salt in the pot
7. Stir until well mixed

### **Fresh egg relish recipe (to be consumed by four people)**

#### Ingredients

- 2 fresh eggs
- Cooking oil
- 1 onion
- 4 tomatoes
- Stock cubes (beef/chicken depending on preference)
- Soup (beef/chicken depending on preference)
- Salt

#### Method

1. Beat two eggs in a bowl
2. Heat cooking oil in a pot and add chopped onions
3. pour the egg mixture in the pot and stir until well combined
4. Add tomatoes and stock cubes and leave to boil until tomatoes are well done
5. Add soup powder and salt in the pot
6. Stir until well mixed

## **APPENDIX F: EGG POWDER AND FRESH EGG SANDWICH RECIPE**

### **Egg powder sandwich recipe (makes two sandwiches)**

#### Ingredients

- 2 levelled table spoons of egg powder
- Cooking oil
- Aromat
- 4 slices of bread

#### Method

1. To reconstitute egg powder add 2 levelled table spoons of egg powder and 4 table spoons of water in a bowl. Combine the egg powder and water until smooth.
2. Heat cooking oil in a pot, add egg powder mixture and stir until well scrambled
3. Add aromat for taste
4. Add the scrambled egg in between two slices of bread
5. Cut the bread in any desired shape

### **Fresh egg sandwich recipe (makes two sandwiches)**

#### Ingredients

- 2 fresh eggs
- Cooking oil
- Aromat
- 4 slices of bread

#### Method

1. Beat two eggs in a bowl
2. Heat cooking oil in a pot, add egg mixture and stir until well scrambled
3. Add aromat for taste
4. Add the scrambled egg in between two slices of bread
5. Cut the bread in any desired shape



## APPENDIX G: SENSORY EVALUATION QUESTIONNAIRE IN ENGLISH

Participant number: -----

Sample number: -----

Gender: -----

Date of birth: |\_\_||\_\_||\_\_||\_\_|

### Instructions

- Please assess the food sample in front of you. Then indicate how you feel about the taste, smell, colour, mouth feel and the overall acceptability by placing **X** over the face indicating your liking.
- Please rinse your mouth with water before starting. You may rinse again at any time during the test if you need to.
- If you have any questions, please ask and you may test the sample as many times as you like

### TASTE



Very bad

Bad

Average

Good

Very good

### TEXTURE



Very bad

Bad

Average

Good

Very good

## AROMA



Very bad

Bad

Average

Good

Very good

## COLOUR



Very bad

Bad

Average

Good

Very good

## OVERALL ACCEPTABILITY



Very bad

Bad

Average

Good

Very good

## APPENDIX H: SENSORY EVALUATION QUESTIONNAIRE IN ISIZULU

Inombolo onikezwe yona: -----

Inombolo yesampulo: -----

Ubulili: -----

Iminyaka: |\_|\_|

### IMIYALELO

- Hlola ukudla okuphambi kwakho. Shono ukuthi ucabangani ngendlela okunambitheka ngayo, iphunga, umbala, indlela okuzwakala ngayo emlonyeni kanye nendlela okuthanda ngayo nje. Khombisa lokhu ngokubeka uphawu [X] eduze kobuso obuqondene nomuzwa wakho.
- Yakaza umlomo ngaphambi kokuba uqale. Ungayakaza futhi nanoma ngasiphi isikhathi ngenkathi uhlola lokudla.
- Uma unomubuzo ungabuza.

### UKUNAMBITHEKA



Kubi impela



Kubi



Mhlawumbe  
Kumnandi  
Noma  
Mhlawumbe  
kubi



Kumnandi



Kumnandi  
impela

### UKUZZA NGEMLOMO



Kubi impela



Kubi



Mhlawumbe  
Kumnandi  
Noma  
Mhlawumbe  
kubi



Kumnandi



Kumnandi  
impela

## IPHUNGA



Kubi impela



Kubi



Mhlawumbe  
Kumnandi  
Noma  
Mhlawumbe  
kubi



Kumnandi



Kumnandi  
impela

## UMBALA



Kubi impela



Kubi



Mhlawumbe  
Kumnandi  
Noma  
Mhlawumbe  
kubi



Kumnandi



Kumnandi  
impela

## ISINQUMO JIKELELE (UKWAMUKELEKA)



Kubi impela



Kubi



Mhlawumbe  
Kumnandi  
Noma  
Mhlawumbe  
kubi



Kumnandi



Kumnandi  
impela

## **APPENDIX I: CONSENT FORM IN ENGLISH**

### **Consent form**

My name is sithandiwe Linda Khoza and I am a full-time student at the University of KwaZulu-Natal registered for Masters in agriculture (food security). I would like you to participate in a study evaluating the acceptance of egg food products. Therefore you will be required to taste egg food products and further rate each samples using a simple picture scale indicating your views on the taste, texture, smell, colour and overall acceptability.

It is essential to know that:

- Participation in this study is voluntary, participants are free to leave the study any time they wish.
- There will be no form of payment for participating in the study
- All information will be kept confidentially and will only be used for the purpose of this study.
- All information will be destroyed when it is no longer needed.
- For any further information with the study, you may contact Dr Kolanisi who is the supervisor of the study at 033 260 6342 or [kolanisi@ukzn.ac.za](mailto:kolanisi@ukzn.ac.za)

Declaration:

I \_\_\_\_\_ (full name and surname) hereby confirm my understanding of the questionnaire and I understand that there will be no risks from the study and I may withdraw if I desire since the study is voluntary.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

## APPENDIX J: CONSENT FORM IN ISIZULU

### Ifomu lemvume

Igama lami ngingu Sithandiwe Linda Khoza, ngingumfundi eNyuvesi yaKwazulu-Natal, ngenza i-Masters kwi Agriculture/kwezolimo (food security). Ngingathanda ukuthi ube yingxenywe yalolu cwaningo mayelana nokwamkeleka kokudla okwenziwe ngamaqanda. Lokhu kusho ukuthi uzodingeka ukuthi unambithe ukudla okwenziwe ngamaqanda bese ukhombisa imibono yakho mayelane noku nambitheka, ukuzwakala emlomeni, iphunga, umbala kanye nesimo sonke jikelele.

Kubalulekile ukuthi wazi okulandelayo:

- Abantu abayingxenywe yalolucwaningo ngokuvolontiya, abantu abayingxenywe yalolucwaningo bavumelekile ukuthi bashiye phakathi kwalo uma bafisa akukho lutho olubi oluyokwenziwa kubona.
- Ayikho imali eyotholwa abantu abayingxenywe yalolucwaningo.
- Imininingwane ezotholakala ngeke isetshenziselwe okunye okuseceleni, izosebenziswa kulolucwaningo kuphela. Imininingwane yabantu abazobe beyingxenywe yalolucwaningo izogodlwa.
- Yonke imininingwane yalolucwaningo izolahlwa uma ingasadingeki.
- Uma udinga eminye imininingwane ngalolucwaningo ungathintana no Dkt. Kolanisi ongumphathi walolucwaningo. Utholakala kule nombolo-033 260 6342 noma [kolanisi@ukzn.ac.za](mailto:kolanisi@ukzn.ac.za).

Izwi lobufakazi:

Mina\_\_\_\_\_ (Amagama aphelele nesibongo) ngiyaqiniseka ukuthi ngichazelekile kahle ngalembuzo engizobuzwa yona futhi ngiyasiqonda isizathu salolucwaningo nokuthi yonke imininingwane etholakele izohlolwa. Ngiyavuma ukuba ingxenywe yalolucwaningo, ngiyaqonda ukuthi kuyavolontiywa ukuba ingxenywe yalolucwaningo nanokuthi ngingashiya phakathi uma ngifisa.

---

Sayina

---

Usuku

## APPENDIX K: ETHICS APPROVAL LETTER FROM UKZN



17 July 2014

Ms Sithandile Khoza 209500150  
School of Agriculture, Earth and Environmental Sciences  
Pietermaritzburg Campus

Dear Ms Khoza:

Protocol reference number: HSS/0718/014M

Project title: The acceptability of egg food products made with commercial egg powder: A proxy for home produced egg powder for household food security

**Full Approval – Expedited**

This letter serves to notify you that your application in connection with the above has now been granted **Full Approval**.

Any alterations to the approved research protocol (i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach/Methods) must be reviewed and approved through an amendment /modification prior to its implementation. Please quote the above reference number for all queries relating to this study. PLEASE NOTE: Research data should be securely stored in the school/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of **3 years** from the date of issue. Thereafter, Recertification must be applied for on an annual basis.

Best wishes for the successful completion of your research protocol.

Yours faithfully,

Dr Shemuka Singh (Chair)  
Humanities & Social Science Research Ethics Committee

/pm

cc Supervisor: Dr Unathi Kalamisi  
cc Academic Liaison: Prof O Mutengwa  
cc School Admin: Ms M Ntshoo

Humanities & Social Sciences Research Ethics Committee

Dr Shemuka Singh (Chair)

Westville Campus, Govan Mbeki Building

Postal Address: Private Bag X04001, Durban 4001

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Website: [www.ukzn.ac.za](http://www.ukzn.ac.za)



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## APPENDIX L: APPROVAL LETTER FROM MKHAMBATHINI MUNICIPALITY

Private Bag X04  
Camperdown  
3720



Tel no: (031) 785 9300  
Fax no: (031) 785 2121

FROM : COMMUNITY SERVICES MANAGER  
TO : WARD COUNCILLORS  
CC : TRADITIONAL LEADERS  
OSS WAR ROOM CHAIRPERSONS  
WARD COMMITTEE MEMBERS  
CCG's, YOUTH AMBASSADORS AND COW's  
DATE : 18 JUNE 2014  
SUBJECT : PARTICIPATION IN FOOD SECURITY RESEARCH - UNIVERSITY OF KWA-ZULU NATAL

The University of KwaZulu-Natal, with the support of Mkhambathini Local Municipality, is conducting a research study on *"The consumption and utilization of indigenous chicken meat and eggs by rural communities. Provitamin A biofortified yellow maize to eradicate hidden hunger"*.

The target group for the said research is mainly households and cooperatives that produce and consume eggs. The anticipated duration of the research is 2 months, starting from the last week of June until end of August 2014.

Dr Unathi Kolanisi and Dr Mthulisi Siwela with 4 post graduate students (University of KwaZulu Natal) will be in contact with each ward/war room to explain further on the research and to set up the interviews.

Your anticipated cooperation and support of this initiative is appreciated. Please contact the Community Services Unit, details indicated above for any enquiries relating to the research study. Dr Kolanisi and Dr Siwela, of the University of KwaZulu-Natal, can also be contacted on 0730548481 and 0724159652 respectively.

Yours sincerely,

MS G.H. BHENGU  
COMMUNITY SERVICES MANAGER